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# AMERICAN RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

**No. 1. Vol. III. New Series.** JULY 1, 1839. **Whole No. 337. Vol. IX.**


The want of a correct statistics of railroads in the United States, and the outrageous assertions recently made in our legislative halls, as to their unprofitableness, have had the effect of prejudicing the minds of a large portion of the community against this most valuable species of improvement. "Speculations," "losing concerns," "public evils," and similar catch words have been repeated and dwelt upon, until even the partizans of the anti-improvement system, have found themselves carried to conclusions which they would fain modify and explain away.

It is but too commonly considered that the estimates of Engineers are ex parte statements, requiring a liberal allowance for prejudice in favor of railroads.

We have, however, now before us, a carefully prepared paper, from a distinguished and unprejudiced foreigner, the Chev. de Gerstner, which must give the highest satisfaction to the friends of internal improvement. Since the arrival of the Chev. de Gerstner, he has collected an immense mass of railroad information, hitherto never yet possessed by any one person.

With his previous preparation, he may now be considered as the only one who has ever yet visited nearly, or perhaps before long, quite, all of the railroads in the world. We hope that every encouragement may be offered to him to publish this, to us, invaluable information. Nothing can have a more favorable effect upon the reputation of our railroads abroad, than such a publication, and it will be to the interest of capitalists, engineers, and all connected with railroads, to aid in forwarding it.

Before we received the communication of the Chev. de Gerstner, we received from Mr. G. Ralston, a file of the Railway Times, to an article in which, he directed our attention, as worthy of notice. The article in question, is a comparison of the English and Belgian railroads, and particular attention is paid to the subject of low rates of fare, as the most profitable. We give on another page, the article referred to with an extract from the letter of Mr. R.

For the American Railroad Journal, and Mechanics' Magazine.

## METEOROLOGICAL RECORD FOR THE MONTHS OF MARCH and APRIL, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W.*)

| 1839 Mar. | Thermometer. Morn. | Noon. | Night | Wind. | Weath. | Remarks. |
|---|---|---|---|---|---|---|
| 1 | 49 | 73 | 68 | S | clear | |
| 2 | 59 | 66 | 54 | SE | cloudy | rain in the morning, evening clear, wind NW [high |
| 3 | 27 | 36 | 33 | N | clear | |
| 4 | 27 | 35 | 39 | .. | .. | |
| 5 | 27 | 54 | 46 | calm | .. | white frost, foggy morning |
| 6 | 32 | 56 | 56 | .. | .. | white frost, night cloudy |
| 7 | 52 | 68 | 60 | .. | cloudy | morning, clear day |
| 8 | 48 | 65 | 54 | .. | clear | foggy morning |
| 9 | 50 | 73 | 64 | S | .. | " " |
| 10 | 54 | 74 | 68 | .. | .. | |
| 11 | 60 | 75 | 66 | .. | .. | |
| 12 | 63 | 77 | 71 | SE | .. | |
| 13 | 67 | 70 | 66 | calm | cloudy | heavy thunder shower in the evening |
| 14 | 51 | 51 | 55 | SW | .. | evening clear |
| 15 | 45 | 70 | 65 | NE | clear | |
| 16 | 48 | 72 | 65 | SE | .. | |
| 17 | 58 | 70 | 66 | calm | cloudy | foggy morning |
| 18 | 63 | 72 | 68 | SW | .. | |
| 19 | 66 | 72 | 68 | .. | .. | light shower in the evening |
| 20 | 68 | 75 | 74 | S | clear | |
| 21 | 68 | 73 | 72 | calm | cloudy | rain in the night |
| 22 | 68 | 64 | 63 | NE | .. | thunder showers forenoon |
| 23 | 52 | 64 | 63 | NW | clear | |
| 24 | 54 | 70 | 66 | .. light | .. | foggy morning |
| 25 | 55 | 65 | 56 | .. | .. | |
| 26 | 44 | 68 | 64 | calm | .. | |
| 27 | 57 | 68 | 68 | S | cloudy | |
| 28 | 67 | 73 | 69 | .. | .. | light showers all day, rain all night |
| 29 | 62 | 67 | 61 | .. | .. | heavy showers all day, night clear, wind N |
| 30 | 46 | 60 | 52 | NW | clear | |
| 31 | 42 | 66 | 64 | N | .. | light white frost |
| | 53.8 | 66 | 61.4 | ............ | ............ | mean temp. of the month 60.4. |
| Apr. | | | | | | |
| 1 | 45 | 70 | 62 | S | clear | |
| 2 | 51 | 70 | 66 | SE | .. | |
| 3 | 60 | 69 | 66 | .. | cloudy | |
| 4 | 57 | 76 | 72 | S | .. | |
| 5 | 63 | 77 | 70 | SE | .. | |
| 6 | 62 | 73 | 63 | calm | .. | rain in the evening and all night |
| 7 | 60 | 74 | 64 | SE | .. | |
| 8 | 60 | 73 | 72 | calm | clear | |
| 9 | 56 | 78 | 73 | S | .. | |
| 10 | 67 | 74 | 72 | .. | cloudy | light showers in the evening |
| 11 | 66 | 80 | 72 | SW | clear | |
| 12 | 58 | 82 | 76 | .. | .. | |
| 13 | 56 | 74 | 70 | .. | .. | |
| 14 | 57 | 75 | 68 | W | .. | |
| 15 | 55 | 82 | 74 | .. | .. | |
| 16 | 62 | 82 | 72 | SW | .. | |
| 17 | 62 | 78 | 68 | .. | .. | foggy morning |
| 18 | 62 | 78 | 76 | .. | .. | " " |
| 19 | 70 | 80 | 78 | .. | .. | morning cloudy |
| 20 | 70 | 79 | 74 | .. | .. | |
| 21 | 63 | 80 | 74 | calm | .. | foggy morning |
| 22 | 66 | 82 | 80 | .. | .. | |
| 23 | 66 | 86 | 82 | SW | .. | |
| 24 | 77 | 84 | 78 | .. | .. | |
| 25 | 65 | 82 | 76 | SE | .. | |
| 26 | 66 | 84 | 80 | .. | .. | |
| 27 | 67 | 84 | 75 | SW | .. | |
| 28 | 68 | 80 | 74 | .. | .. | |
| 29 | 67 | 80 | 76 | S | .. | morning cloudy |
| 30 | 66 | 78 | 76 | .. | .. | " " |
| | 62.3 | 78.1 | 72.6 | ............ | ............ | mean temp. of the month, 71. |

For the American Railroad Journal and Mecnanics' Magazine.

Messrs. Editors:—I have read the essays of X., in relation to the Reading Railroad, addressed to E. Chauncy, Esq. with great interest. He gives us the long desired data to come out, "*Railroads v. Canals.*"—On this subject, it is high time we took ground. The public have been led astray by the engineers, both in England and the United States, from mutual success with canals in the first instance. In this State we have carried the canal mania to an extent that will cost us upwards of $20,000,000, *actually thrown away*, viz. in the enlargement of the Erie Canal, in the construction of the Chenango, Black River, and Genesee Valley Canals, constructed in sections of the country not adapted to canals, but eminently suited to railroads, and the extension of railroads, to points where there is not water to continue these canals. Our State, in 1835, adopted the errors and prejudices of English engineers, collected of the chairman of the committee on canals in congress, to prove the importance of the Chesapeake and the Ohio canal, and the advantages that work would have over a railroad.

If I recollect, a railroad was placed as middle ground, between a common road and a canal—viz. in the relation of a turnpike, to these improvements. The state engineers of New York placed the actual *cost* of transporting a ton a mile on a level railroad at 3½ cents per mile. This opinion, coming from such a source, with the sanction of a highly respectable canal board, and in an official report, carried the laws for the construction of the before named canals, and has retarded railroads full ten years in this State, whilst our neighbors to the east and south, have pushed them forward with vigor.

The essays alluded to, presents the following comparison between the Philadelphia Reading *Railroad* and the Schuylkill *Canal*, as to the actual cost of transporting a ton of coals from the mines to tide water at Philadelphia, for the minute details of which, I refer you to the essay you were so good as to furnish me. The entire publication of these essays will add much to the cause of railroads.

| | |
|---|---|
| "The present cost of transporting one ton of coal 108 miles to the Schuylkill, which includes 92 cents toll, the present charge is | $3 23 1-2 |
| The total cost per ton for freighting and shipping by the Reading Railroad, 94 miles to the Delaware river, is 78 3-4, add toll, 1-2 cent per ton per mile, 47, - - - - - | 1 25 3-4 |
| Difference in favor of the Railroad, - - - - - | 1 97 3-4 |

By this view of the subject, it appears that one of our best constructed canals, receives 3 1-4 cents per ton per mile, whilst the rail road along side of it, proposes to do the same business at 1 1-4 cents per ton per mile. This may be too low, but they certainly can compete with the canal.

That there is fear, that the Utica and Schenectady rail road, can compete with the Erie canal in tho transportation of goods and produce, *even paying canal tolls!!* is evinced, by the last legislature refusing that com-

pany to carry freight during the summer, but restricting them to the winter months, then to pay canal tolls. Of course the company cannot go to the expence of freight cars, &c., for so short a period, on such onerous terms.

J. E. B.

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*Correction.*—In the table furnished us by J. E. Bloomfield for our June number, stating the cost, expenses and income of the three principal roads in Massachusetts, also of the Utica and Schenectady railroad in this State for the last year, the nett per centage earned, was blended in the column with the cost of the several roads, instead of being placed in a seperate column.

| | | | |
|---|---|---|---|
| The Boston and Lowell road earned nett, | | | 7 1-3 per cent. |
| " Boston and Providence, | " | " | 8 1-4 " " |
| " Boston and Worcester, | " | " | 8 " " |
| " Utica and Schenectady, | " | " | 12 " " |

It has been ascertained by the Chevalier De Gerstner, that the average cost of 3000 miles of railroads, completed in the United States, is about $20,000 per mile, and that the average nett income, in their present incipient state, and sparce population, yields 5 1-2 per cent. on the cost.

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For the American Railroad Journal and Mechanics' Magazine.

London, May 28, 1839.
No. 7, Token House Yard.

Gent:—I Send you the "Railway Times" of the 18th inst., with the view of requesting you to republish in your excellent "American Railroad Journal," a very sensible article headed "Railway fares," wherein the impolicy of high charges on railways, and the policy and profits of low charges are clearly pointed out. My opinion is, that in a populous country the lower you can reduce the expenses of locomotion, consistent with reason, the larger will be the profits of the railway proprietors, and the more extensive, of course, will be the benefits of this invaluable species of improvements, diffused through the community. This remark applies particularly to countries like Belgium and Great Britain, and to parts of our own country—say, for example, from Boston to Washington, including Providence, New York, Philadelphia, and Baltimore, where the travelling is exceedingly great, and will be made infinitely greater by low fares. I think the fares on our American railways are too high, and sound policy will dictate a considerable reduction of them. By publishing the excellent article I point out to you, the attention of the Directors of our public works in the United States, may be attracted to the subject, and the evil may be remedied.

The extension of the railway system in this country, is very rapid, but nothing in comparison with what is done and doing in our country. If we had some more of the spare capital of this country, we could show the good people of Europe how to make these improvementr rapidly. They

move on very slowly in this country, having lawyers, parliament, and the landed aristocracy, to throw every possible impediment in the way, and to make them pay the most exorbitant prices for land, &c., whilst in America, Government and individuals give all possible facilities to the erection of these admirable labor-saving machines, and the result is, whilst their principal railways cost from 50,000 to 70,000*l* per mile, and are treble the time in progress that ours are, our railways cost on an average, 8,444*l** per mile, and are frequently completed, before an act of parliament can be procured to authorize the commencement of the work in this country. It is to be hoped that the vexations attending these important works will be removed, as their value becomes more generally known.

I was rejoiced to learn that the Birmingham and Glocester Railway Company of this country, had ordered some locomotives to be made for them by Mr. Norris, of Philadelphia. I am also highly gratified to hear that several railway companies in Germany have ordered a considerable number of these machines from our country. I sincerely hope they will turn out such excellent instruments, that a continuance of these orders will flow into our ingenious and skilful mechanics in the United States.

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RAILROADS IN THE KINGDOM OF BELGIUM COMPARED WITH THOSE IN THE UNITED STATES.

The rapid increase of Internal Improvements in the United States has excited for several years public attention in Europe, and the friends of those improvements desired very much a detailed report on the extent and progress of those works, and particularly of *Railroads* There is no such report furnished in the United States, and even those published in England, France, and Germany are very imperfect.

In 1824 I had charge of the first railroad on the continent of Europe to connect the rivers Moldau and Danube in Austria, by a line which is 130 miles long, and since 1832 in operation. I constructed in 1836 and 1837 the first railroad in Russia, from St. Petersburg to Zarskoe-Selo and Pawlowsk, a line of only 17 miles in length, but the commencement of a railroad of 420 miles from St. Petersburgh to Moscow. This railroad being likewise in full operation, I left Europe last fall, and arrived in the Great Western on the 15th of November, 1838, at New York. After a short stay of a few days I went to Albany, and inspected all railroads between that place and Lake Erie; I then proceeded to the Eastern States, and visited all railroads in Massachusetts, and went via New York, Philadelphia, Baltimore, Washington, through Virginia, North and South Carolina, Georgia, and Alabama, to New Orleans, always visiting the railroad lines in the different States. I went then up the Mississippi and Ohio, and am now inspecting the internal improvements of the Western States, and some of those in Pennsylvania, which I have not yet seen.

I have already passed over more than 2000 miles of railroads, and have every where been received with the greatest kindness; the presidents, directors, and engineers of the different railroad lines gave me not only all their printed reports, but laid before me, with the greatest liberality, their

*See Report in your March number, page 178, of the Housatonic Railway Company, where the average cost of twelve principal American Rail Roads is stated to be $38,000 or £8,444. G. R.

books and accounts, in order to give me every kind of information. I fulfil only my duty when I publicly acknowledge, that such a liberality is only to be found amongst a free and enlightened people, where all public works are based on the principle of publicity, and where secrets do not exist. I wish, therefore, to make those gentlemen, to whom I am so much indebted, another communication, which will show at the same time what has been done during the last years in Europe. Having within a few days received the last reports of the Belgian railroads, I publish in the following abstract the history and progress of those communications in Belgium, together with a comparison of them with the American railroads.

According to the facts collected during my travels since my arrival in New York, there are now *over three thousand miles of railroads completed and in operation in the United States;* 425 locomotives, of which the greatest number were made in this conntry, run on the several railroads, and I believe that up to the end of 1839, the length of railroads in the United States may amount to 4100 miles. The capital expended on the railroads now in operation is about sixty millions of dollars, or at an average cost of twenty thousand dollars per mile, for which sum the railroads, with the buildings, have been constructed, and the necessary locomotives and cars bought.

Several railroads have been undertaken with insufficient means, and the shareholders found themselves under the necessity of employing the income of the first years in improving the railroad, in building engine houses, &c. and purchasing locomotives and cars. In consequence of this the shareholders got during that time no dividends, but the railroad still yielded a good income. Other railroads, when finished, paid from five to ten per cent. income to the stockholders; others have not yet paid any dividends, for want of a sufficient number of passengers and freight. The *average result* of the railroads now in operation in the United States is, *that they give a yearly interest of five and a half per cent. on the capital invested.* This result may be regarded as very satisfactory, because the greatest part of the lines have only been a few years in operation.

On all lines there is a yearly increase of at least 15 to 20 per cent. in the gross income, so that even those lines which do not pay now will give in a few years a handsome dividend. According to these statements, based on the communications collected in this country, I have no doubt that the large capital invested in railroads in the United States, will not only produce an incalculable benefit to the country, but also pay the shareholders a dividend, which, under good management, by the constant progress in population and trade, must likewise from year to year increase.

A good book-keeping and clear accounts is in every business a matter of importance; railroads are new constructions, and experience particularly in working them, is still very much wanted. When the superintendent of a railroad in operation keeps clear and distinct accounts, he will in a few years learn by experience what can be improved, and which items of expenses can be reduced. The following statement contains a manner of making the railroad accounts, which in my opinion must prove very useful for every railroad company.

## I. *History, length, and cost of construction of the Belgian Railroads.*

The railroads, which, up to the present time, have been constructed in England and on the continent of Europe, had no other object than to connect two important places of the country, and in constructing them, therefore, only a local interest more or less prevailed. That railroads are to be considered *as great thoroughfares*, that they can form in a country the

principal lines of internal communication—that, therefore, the means for their establishment should be such as can only be raised by a whole nation, nobody in Europe would maintain previous to the year 1834, and is even now denied by many persons of high standing and influence. Belgium, united with Holland since 1815, had distinguished itself in Europe by its fine roads, and magnificent canals; the latter, being constructed for the greatest part in a level country, and without locks, were used not only for the transportation of goods, but for passengers, especially the lower classes, which there, more than in any other country, made use of the canal boats for their travels. It is evident, that no individuals would ever have attempted to construct railroads parallel and in opposition to such canals and turnpike roads.

In the year 1830, Belgium declared itself independent of Holland, and elected by the representatives of the nation its own sovereign. King Leopold I. soon discovered, that the country, for its perfect tranquility, wants "labor;" a series of wise legislation encouraged the nation to useful and profitable enterprizes, and every person with talent and inclination found employment and earnings in a country, which, isolated from its neighbors, was confined to its own resources. But to gain the public opinion, a great national work was to be accomplished by the new government, able to fill posterity with admiration. The time was past for Egyptian pyramids, for Roman triumphal arches, and French monuments of war. A more useful monument, one of peace and intelligence, should remind the nation of that eventful period. The king ordered the whole country to be surveyed by able engineers, the necessary plans and estimates formed, and on the first of May, 1834, a law was proclaimed, according to which *a system of railroads should be introduced through the whole kingdom, and executed at the expense of the State;* on two points, (at Antwerp and Ostend.) the railroads were to lead to the seaports, on two points to connect with France, and on one point to connect with Prussia, (Germany.)

The news of the gigantic work, undertaken by a State, even not yet acknowledged as such by the Northern powers, and with only four millions of inhabitants, excited the greatest surprise in Europe, and few only could conceive the great results, which this grand project must necessarily produce *on the independence of the nation and its internal welfare,* its commerce and industry; the former being the principal aim and the promotion of commerce and industry a subordinate one, although the great mass of the people were unable to comprehend the grand idea of the plan.

King Leopold found in his former minister of puulic works, Mr. De Theux, and in his successor Mr. Nothomb, vigorous supporters. The Engineers were vying in the swift prosecution of the work, and in the course of four years, more has been done than was expected. The enlightened minister Nothomb published annual reports to the Legislative Assembly, besides other special reports of the progress of the works, in which the public in Europe find a rich source of experience, not to be met with in any report or work on the subject. Europe has to render thanks to the King, who the first realized such a grand idea, and to his enlightened minister, who judiciously conducted the work, and so liberally communicated its results.

The limited space of this report does not allow a detailed extract from the above mentioned reports of the minister Nothomb and the Engineers, I shall therefore only give a brief account containing the results in numbers, and afterwards compare these results with those of Railroads in the United States. The following table contains the sections of the Railroads

which were opened until the end of 1838, and their length in mètres and English miles.

| Section of Railroads. From | To | Time of opening. | Length. In French mètres. | In English miles. |
|---|---|---|---|---|
| Brussels, | Malines, | 5 May, 1835, | 20,300, | 12.6 |
| Malines, | Antwerp, | 3 May, 1836, | 23,500, | 14.6 |
| Malines, | Termonde, | 2 Jan., 1837, | 26,700, | 16.5 |
| Malines, | Louvain, | 10 Sept., 1837, | 23,750, | 14.7 |
| Louvain, | Tirlemont, | 22 Sept., 1837, | 17,745, | 11.0 |
| Termonde, | Gent, | 28 Sept., 1837, | 30,500, | 18.9 |
| Tirlemont, | Waremme, | 2 April, 1838, | 27,200, | 16.8 |
| Waremme, | Ans, | 2 April, 1838, | 18,900, | 11.7 |
| Gent, | Bruges, | 12 Aug., 1838 | 44,500, | 27.6 |
| Bruges, | Ostend, | 28 Aug., 1838, | 23,500, | 14.6 |
| | | Total, | 256,600, | 159.0 |

According to the report, made by the minister to the House of Representatives, on the 26th November 1838, the above ten sections including buildings, locomotives and cars, cost 34,000,000 francs; this gives per mile of Road 41,300 dollars. The Railroad from Brussels to Antwerp, 27.2 miles, has a double track, the remainder are constructed only with a single track, the rails weighing 45 lbs. per yard. But there are several buildings yet to be erected, and different works on the line to be executed, and besides a number of freight cars to be provided for, &c.; with all this the cost per mile will amount to 45,000 dollars.

## II. *Tariff For Passengers, Speed.*

There are on the Belgian railroads four classes of passenger cars, differing only in elegance and comfort, but going in the same train, and therefore with equal velocity. The prices are:

| | | |
|---|---|---|
| In the Berlines, | $2\frac{1}{3}$ cents per mile, | For each passenger with 44 lbs. of baggage. |
| " Diligences, | 2 " " " | |
| " Chars à Bancs, | $1\frac{1}{3}$ " " " | |
| " Waggons, | 0.8 " " " | |

The trains perform at an average 17 Eng. miles per hour, all stoppages included, or from 20 to 25 miles while running.

## III. *Traffic and Revenue of the Belgian Railroads.*

The railroads in Belgium are frequented by more passengers than any other Railroads; the transportation of freight was only begun between Brussels and Antwerp, in 1838. The following table shows the travel since the opening of the first section, until the 31st of October, 1838.

| Period. | Total number of passengers. | Average distance performed by each passenger. | Number of passengers reduced for one mile. | Gross income. From all passengers. | | Gross income. per passengers. per mile. |
|---|---|---|---|---|---|---|
| | | Miles. | | Francs. | Dollars | Amer. cts. |
| 5th May 1836 to 2d May 1836 | 563,201 | 11.6 | 6,536,754 | 359,394 | 67.429 | 1.03 |
| 3d May to 31st Dec. 1836. | 729,545 | 20 2 | 14,718,709 | 734,736 | 137.849 | 0.90 |
| In the year 1837, | 1,384,577 | 17.2 | 23,838,436 | 6,416.983 | 265,850 | 1.11 |
| 1st Jan. to 31st Oct. 1838, | 1,921,619 | 22.8 | 43,887,864 | 2,589,384 | 485,813 | 1.11 |
| In 3 years 6 months, | 4,598,942 | 19.35 | 88,981,763 | 5,100,497 | 956,941 | 1.07 |

to which must be added 44,148 francs, or 8,281 dollars, as the gross income from freight in the year 1838.

In the year 1837 there were 30,857 soldiers under the number of passengers, for whom, in consequence of an arrangement with the ministry of the War Department, only half price was paid.

In 1838, the total number of passengers amounted, according to the "Moniteur Belge," to 2,238,303, comprising 56,618 soldiers, and the gross income was 3,100,833 francs 40 centimes [581,770 dollars.] As the average distance performed by each passenger in the first 10 months of 1838, is not mentioned in the report of the Minister, I supposed the income per passenger per mile to be the same as in 1837, out of which results an average distance of 22.8 miles. In order to show how the travelling public made use of the different classes of cars, the following contains the number of passengers in each class of cars, and the revenue resulting therefrom for the year ending 31st December, 1838. During this period there were

| | | | | |
|---|---|---|---|---|
| 17,503 | passengers, | I. class, | who paid | 69,322 francs 65 centimes. |
| 215,893 | " | II. class, | " | 702,502 francs 70 centimes. |
| 604,935 | " | III. class, | " | 1,033,953 francs 05 centimes. |
| 1,343,354 | " | IV. class, | " | 1,087,790 francs 45 centimes. |
| 56,618 | soldiers, | | | 45,248 francs 88 centimes. |
| | For overweight of baggage, and freight, | | | 162,015 francs 67 centimes. |
| 2,238,303 | passengers, and total income, | | | 3,100,833 francs 40 centimes. |

These numbers explain sufficiently that the railroads in Belgium are used principally by the lower classes of the people.

### IV. *Cost of working the Belgian Railroads.*

The accounts kept under this head contain an exact subdivision of the different expenses occurring in working the railroads; the first general subdivision contains *the maintenance of way and police*; the second *the cost of transportation*, viz. fuel, engineers and firemen, repairs of locomotives and cars, grease for the same, also the expenses for conductors, carriers and baggage men; the third embraces *the general expenses*, viz. clerks and ticket sellers, comptrollers, printing, advertising, office expenses, &c. The annexed table contains the expenses under the different heads:

| Period. | Maintenance of way & police. | Transportation account. | General expenses. | Total. | |
|---|---|---|---|---|---|
| | FRANCS. | FRANCS. | FRANCS. | FRANCS. | DOLLARS. |
| 5th May to 31st Dec. 1835 | 50,584 01 | 105,967 88 | 12,220 84 | 168,772 73 | 31,665 |
| Year 1836 | 132,637 41 | 261,778 30 | 36,719 96 | 431,135 67 | 80,888 |
| Year 1837 | 345,824 53 | 664,940 46 | 144,706 92 | 1,155,471 91 | 216,786 |
| 1st Jan. to 31st Oct. 1838, | 377,822 58 | 1,059,180 71 | 182,186 48 | 1,619,189 77 | 303,788 |
| In 3 years and 6 months, | 906,868 53 or 27 pr ct | 2,091,867 35 or 62 pr ct | 375,834 20 or 11 pr ct | 3,374,570 08 or 100 pr ct | 633,127 |

As this table contains the expenses of working the railroads 3 1-2 years, these numbers may certainly be regarded as the result of a great experience.

### V. *Cost of repairs of Locomotives and Cars.*

In the last table, the sum of 1,059,180 francs, 71 centimes, appears under the head of transportation account for ten months in 1838. This sum contains the expenses for foremen in the shops,

| | |
|---|---|
| tains the expenses for foremen in the shops, | 32,177f. 54c. |
| For laborers, . . . | 187,463f. 61c. |
| At the principal shops in Malines, . | 54,868f. 72c. |
| For materials for repairs, . . | 87,965f. 66c. |
| Total, | 362,475f. 53c. |

or 68,006 dollars, which is 34 per cent. of the expenses of transportation. I believe that the expenses for repairs of engines and cars, might be diminished by the introduction of locomotives with moveable trucks in front, and of eight wheeled passenger and freight cars.

VI. *Expenses per Passenger per mile.*

The accurate number of miles performed by passengers not being contained in the last report, the expenses per passenger per mile can only be found up to the end of 1837. According to the last statement, the expenses from the 5th of May 1835, to the 31st of December 1837, were:

| | |
|---|---|
| For maintenance of way, | 529,045f. 95c. |
| Transportation account, | 1,032,686f. 64c. |
| General expenses, | 193,647f. 72c. |
| Total, | 1,755,380f. 31c. |

During the same period, the number of passengers reduced to 1 mile was equal to 45,093,899, which divided in the above, gives as the expenses per passenger per mile,

| | | |
|---|---|---|
| For maintenance of way, | 1.17 centimes, | or 0.22 cents. |
| Transportation account, | 2.29 centimes, | or 0.43 cents. |
| General expenses, | 0.43 centimes, | or 0.08 cents. |
| Total, | 3.89 centimes, | or 0.73 cents. |

These expenses are very low, and are exceeded on every other railroad.

VII. *Expenses per mile of travel.*

The number of miles performed by all the locomotives with their trains was:

| | |
|---|---|
| From 5th May 1835, to 2d May 1836, | 14,810 lieues. |
| From 3d May 1836, to 31st December 1836, | 24,825 lieues. |
| From 1st January 1837, to 31st December 1837, | 61,592 lieues. |
| Total, | 101,227 lieues. |

at 5,000 métres, or 314,506 English miles; the expenses during the same period of two years and eight months, were

| | | |
|---|---|---|
| For maintenance of way, per mile of travel, | 529,045f. 95c. therefore | 1f. 68c. or 31½ cents. |
| For transportion account, per mile of travel, | 1,032,686f. 64c. therefore | 3f. 28c. or 61½ cents. |
| General expenses, per mile of travel, | 193,647f. 72c. therefore | 0f. 62c. or 12 cents. |
| Total, | 1,755,380f. 31c. | 5f. 58c. or 105 cents. |

The expenses for every mile which a locomotive with its train runs, amount therefore to 5 francs 58 centimes, or 1 dollar 5 cents, being very near the same as on the American railroads.

VIII. *Number of Passengers per trip.*

In the table under No. 3, we have shown that the number of passengers from the 5th of May 1835, to the 31st of December 1837, reduced for the length of a single mile of road, amount to 45,093,899; during the same period, the trains performed 314,506 miles; this gives 143 as the average number of passengers in a train. This number compared with 5f. 58c. as the expenses per mile of travel, gives again 3.89c. or 0.73 cents as the expense per passenger per mile.

## IX. *Comparison between the gross income and the nett revenue.*

The following table contains the annual gross income, current expenses and the surplus of income over the expenses, as is related in the report of the Minister of the 26th of November 1838, to which is annexed the annual surplus for every 100 francs of the gross income.

| Period. | Total gross income. FRANCS. C. | Current expenses. FRANCS. C. | Surplus of the revenue over the expenses. FRANCS. CENT. | From 100 f. of the gross income reman'd after defraying all expenses. |
|---|---|---|---|---|
| 5th May to 31st Dec. 1835, | 268,997 50 | 168,772 73 | 100,224 77 | 37f. 26 centimes. |
| Year 1836, | 825,132 85 | 431,135 67 | 393.997 18 | 47f. 75 " |
| Year 1837, | 1,416,982 94 | 1,155,471 91 | 261,511 03 | 18f. 46 " |
| 1st Jan. to 31st Dec. 1838. | 2.633.532 21 | 1,619,189 77 | 1.014.342 44 | 38f. 52 " |
| Total, | 5,144,645 50 | 3,374,570 08 | 1,770,075 42 | 34f. 41 centimes. |

As an average therefore, of 3 1-2 years, of every 100 francs revenue, only 34 francs 41 centimes remained, but as all the locomotives and cars are still new, and no amount for general depreciation appears under the expenses, it is to be supposed, that in future only 30 francs will remain from 100. This surplus serves as interest and a sinking fund for the capital.

## X. *Gross income per mile of railroad.*

The public in Europe is almost throughout of opinion, that only short lines, and these especially between two populous cities, will pay a good interest, but the branch roads extending to remote, less populated parts of a country will never yield any profits. What results the Belgian roads give in that respect, the annexed table will show:

| Period. | No. of sect's. op'n'd | Average length of road in operation. | Gross income during whole period FRANCS. CENT. | Annual income per single mile of road. FRANCS. CT. | DOLLARS |
|---|---|---|---|---|---|
| 5th May to 31st Dec. 1835, | 1 | 12.6 | 268,997 50 | 32,333 75 | 6,066 |
| Year 1836, | 2 | 22.3 | 852,132 85 | 38,212 23 | 7,169 |
| Year 1837, | 6 | 56.1 | 1,416,982 94 | 25,258 16 | 4,739 |
| 1st Jan. to 31st Oct. 1838. | 10 | 118.7 | 2,633,532 21 | 26,638 34 | 4,998 |
| Total | | 53.1 | 5,144,645 50 | 27,735 98 | 5,204 |

In the second column appears for the year 1835, only the section between Brussels and Malines of 12.6 miles, opened at that time. In the year 1836, these 12.6 miles were in operation for 365 days, and the second section from Malines to Antwerp, of 14.6 miles, for 243 days only. In multiplying the length of each section by the respective numbers of days, and dividing the sum by 365, we receive 22.3 miles as the average length in operation during the whole year 1836. In the same manner, the average length was obtained for the years 1837 and 1838. The last column shows, that the annual receipt per single mile of road amounted in the first year, when the novelty attracted many passengers, and only 12.6 miles were opened, to 32,333 francs 75 centimes, and that in the 3d and 4th year, when curiosity attracted but few, and the greatest number travelled for business only, and while a much greater length of road was in operation, these receipts amounted still to 26,500 francs per mile yearly. This amount will undoubtedly be increased in the following years, as in 1838 four new sections came in operation, on which the traffic will develope itself only by and by; besides, there will be the transportation of goods, which for the year 1839, is estimated to give a revenue of 850,000 francs for 159 miles, or 5346 francs per mile; the gross income on the Belgian railroads, will therefore also in future, like the first year, amount to about 32,000 francs per mile of road annually. That by the increase of population and com-

merce, also this income of 32,000 francs will be increased, is evident; the railroads in Belgium serve therefore as a proof, that long lines of railroads may (some extraordinary circumstances excepted,) be executed with equal success as short ones.

It would be quite erroneous in calculating the revenue of a system of railroads, canals, or turnpike roads, to regard the income on the principal line separately, and so the revenue of each of the branch lines, in order to judge of the value of each of them. By the opening of a branch line the income of the main line must become greater; because the passengers and freight from the branch lines will pass over the same and increase the revenue. The accurate way of calculating a whole system of railroads, canals, or turpike roads, must therefore be to compare the *total income of the main line as well as of the branch lines*, with the *total length of all the lines*, in order to find the *average income per mile;* and in deducting therefrom the expenses, the balance will show, when compared with the cost of construction per mile, what interest ensues for the capital invested.

XI. *Budget for the operations of the Belgian railroads in the year* 1839.

We have seen that the annual gross income will amount to 32,000 francs per mile, therefore for the 159 miles, which are in operation, to 5,088,000 francs. After defraying all the expenses from 100 francs gross receipts, there remain 34 francs 41 centimes, the nett income will, therefore, be 1,750,780 francs, instead of which the minister in his Budget anticipates the amount at 1,700,000, to which he is led by a different calculation. This surplus is exactly 5 per cent. of the capital expended of 34,000,000 francs. These 5 per cent. suffice for interest and sinking fund, and therefore the Belgian railroads fulfil their object, to maintain themselves without being a charge to the State Treasury.

XII. *Increase of income from the mail and turnpikes.*

As an objection against railroads, it was further maintained, that their introduction in a country will lessen considerably the receipts of tolls on turnpike roads and of the mail, because there will be less travel on turnpike roads, and letters will be carried by persons who travel on railroads; the same opinion appears to have existed in Belgium. On the 27th of January 1838, the Minister, Mr. Nothomb, declared in the Senate, that the revenue of the mail in 1837, exceeded that of 1836 by 262,373 francs, and the tolls on turnpike roads, by 110,000 francs, for the reason that although the tolls on those roads which go in a parallel direction with railroads, are lessened, yet they are increased in a greater proportion on those turnpike roads which lead to the railroads, as they are passed over by all who come to travel on the latter. The revenue from the mail increased in consequence of the greater intercourse occasioned by the introduction of railroads.

XIII. *Comparison of the Belgian railroads with those in the United States.*

According to table under No. 3, the number of passengers during 3 1-2 years, reduced for the length of one mile, amounted on the Belgian railroads, to 88,981,763, or at an average per year of 24,423,361. As the average length of road in operation during the whole time, was 53.1 miles, we have 478,783 through passengers annually. The *Belgian railroads are therefore travelled over on their whole length by nearly* 500,000 *passengers per year.* We have now the following comparison:

[*a.*] *Cost of construction.*—A mile of railroad with a single track, and

the necessary buildings and outfit, costs in America 20,000 dollars; in Belgium 41,300 dollars, or more than twice the amount.

[*b.*] *Tariff.*—On the American railroads, a passenger pays at an average 5 cents per mile; on the Belgian railroads, only 1 cent or five times less; for freight the charge is, in America, at an average of 7 1-2 cents per ton per mile.

[*c.*] *Speed.*—On the American railroads, passengers are conveyed with a speed of from 12 to 15 miles per hour, stoppages included; on the Belgian roads at the rate of 17 miles, or stoppages not included, at the rate of from 20 to 25 miles.

[*d.*] *Traffic.*—There are at an average, 35,000 through passengers, and 15,000 tons of goods carried annually over the American roads; on the Belgian, there have been carried per year 478,783 through passengers, and the transportation of goods only commenced a short time since.

[*e.*] *Gross income.*—The same amounts on the American railroads, at an average per mile and per year.

| | | |
|---|---|---|
| From 35,000 passengers at 5 cents, | 1,750 | Dollars. |
| From 15,000 tons of goods, at 7 1-2 cents, | 1,125 | " |
| From mail and contingencies, | 200 | " |
| Total, | 3,075 | " |

On the Belgian railroads, the gross income per mile from 478,783 passengers, and the transportation of freight amounts to 32,000 francs or 6,003 dollars 75 cents per year.

[*f.*] *Expenses per mile of travel.*—These amount on the American railroads to 1 dollar, on the Belgian roads to 1 dollar 5 cents, or they are the same in both countries.

[*g.*] *Number of passengers per trip.*—In Belgium there were in each train, at an average of 3 1-2 years, 143 through passengers; on the American roads, a passenger train contains only 40 through prssengers, at an average.

[*h.*] *Number of trips per year.*—In dividing 35,000 by 40, we obtain 875, as the average number of passenger trips per year, on the American railroads; and in dividing 478,783 by 143, we get 3,348, which represents the average number of passenger trains passing annually over the Belgian roads. As at the same time the speed on the latter is greater than on the American railroad, it was necessary to employ rails of 45 lbs. per yard, while their weight is generally less on the American railroads.

[*i.*] *Expenses per passenger per mile.*—These are in Belgium only 0.73 cents, and in America 2 1-2 cents, or 3 1-2 times more. The reason of it is, that the American trains contain 3 1-2 times less passengers, while the expenses per train per mile are equal in both countries. It is very nearly the same for a locomotive to carry 40 or 143 passengers in a train.

[*k.*] *Annual current expenses.*—In America, the annual current expenses for working a railroad, are per mile,

| | | | |
|---|---|---|---|
| For transportation of | 35,000 passengers, at 2 1-2 cents, | 875 | dollars. |
| " | 15,000 tons of goods, at 6 1-2 cents, | 975 | " |
| " | the mail and other expenses, | 100 | " |
| | Total, | 1,950 | " |

Or 63 dollars 41 cents, of every 100 dollars gross income. On the Belgian railroads, of every 100 dollars gross revenue, the expenses are 65 dollars 59 cents, or per year per mile 3,937 dollars 86 cents.

[*l.*] *Interest on the capital invested.*—In America, the annual average gross income, per mile of road, amounts to 3,075 dollars, the annual cur-

rent expenses to 1,950, leaving 1,125 dollars, which compared with the cost of a mile of road [20,000 dollars,] give 5 1-2 per cent. interest. On the railroads in Belgium, the annual gross income per mile, is 6,003 dollars 75 cents, the expenses 3,937 dollars 86 cents, leaving 2,065 dollars 89 cents as interest on the cost of 41,300 dollars per mile, or exactly 5 per cent.

### XIV. *General Remarks.*

The comparison of the results of the Belgian railroads with those of the railroads in the United States of America, speaks evidently in favor of the first. The extremely low charges for passage on the Belgian railroads has increased the number of passengers in an unparalleled degree, and produced an intercourse not attained in any other country of the world. While the higher prices in the better classes of cars yield a considerable profit, the price in the last class or for the great mass of the people, is so low that it almost only covers the expenses. The Belgian railroads are, therefore, throughout a great popular, democratic establishment, which must have found the approbation of the people and every intelligent man; the Belgian railroads afford to the government the greatest facility in the transportation of troops, the importance of which was evinced principally for the last years; the Belgian railroads yield, in conformity with the grand idea of their establishment, only the interest and sinking fund of their capital, but the State treasury has, by the increase of intercourse, indirectly gained in all taxes, in the revenue from tolls on turnpike roads and from the mail; the most important gain, however, was that kept in view by the great founder of these roads, to bring the nation into a more intimate contact, and to form of it one large family, on which the actual national device: "L'Union fait la force," [" Union gives strength,"] becomes realized.

F. A. CHEVALIER DE GERSTNER.

Cincinnati 25th June, 1839.

*** Letters addressed to the care of Messrs. MAITLAND, KENNEDY & Co., New York.

☞ Five francs and 33 centimes, or 533 French centimes, are equal to one dollar. One English mile is equal to 1610 mètres.

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### RAILWAY FARES.

The *Midland Counties Herald* calls attention to a paper on "Railways in Belgium," which appears in a recent number of the *Journal of the London Statistical Society*, and which contains some statements with reference to fares on railways, that will no doubt be interesting to many of our readers. It should be mentioned that Belgium is the first state in Europe which has established a general system of railways, planned and executed by the government at the public cost. The project was put forth in 1833, the total length of the lines determined upon in the first law passed on the subject, being 239 1-4 English miles, of which 159 1-2 are now completed, and the remaining lines are expected to be opened in the present and the next year. The line from Mechlin to Brussels was opened in 1835, and that from Mechlin to Antwerp in 1836, and the remaining lines were completed in 1837 and 1838. "With reference to the amount of profit which the Belgian government looks forward to receiving from the railways, [observes the writer,] it is necessary to state the view which they take of their position as proprietors. The undertaking might be prosecuted upon three different systems. 1st. As a work of public utility, without requiring that the receipts should cover the expenditure. 2d. As a financial resource, and requiring that the receipts should exceed the expenditure, and yield an

income for public purposes, like the post office in England. 3d. As an establishment which should neither be a burthen nor a source of revenue, and requiring merely that it should cover its own expenses, consisting of the charge for maintenance and repairs, with a further sum for the interest and gradual redemption of the invested capital. The Belgian government adopts the last system, and expects to realise an annual profit of five per ct. upon the original outlay beyond the current expenses. It has, however, been estimated, that the line from Brussels to Antwerp will yield 16 per cent." The following are the remarks on the subject of fares above alluded to:—

"The carriages on the Belgian lines are divided into four classes, the fares of which vary according to the degree of comfort which the conveyances possess. They present a great contrast, as regards amount, with the English fares. The average charge per post league of four thousand mètres, or four thousand three hundred and seventy-four yards, is—

In Berlins, 35 c; equal to 14.08 c, or less than 1 1-2*d* per mile.
In Diligences, 30 c; equal to 12.06 c., or less than 1 1-4*d* per mile.
In Chars-à-banc, 20 c; equal to 8.04 c., or rather more than 3-4*d* pr mile.
In Wagons, 10 c; equal to 4.02 c., or rather less than 1-2*d* per mile.

"There are also wagons for the transport of merchandise, but it is only since the commencement of 1838 that heavy goods have been conveyed by this means. Previous to that period not even the carriages of persons travelling by the railway could accompany them; it was necessary to forward them by the ordinary roads.

(To be continued.)

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## ALLEGANY MOUNTAINS—THE LOWEST DEPRESSIONS OR SUMMITS FOR RAILROADS FROM SOUTH CAROLINA TO MASSACHUSETTS.

The science of civil engineering, with the competition of the several States, to develope railroad routes from the Atlantic to the valley of the Ohio, has presented some facts in relation to the lowest depressions to pass "the back bone" of the United States, from South Carolina to the north west part of the State of New York, which are interesting to the city of New York and this State.

The South Carolina surveys to connect Charleston by the Butt Mountain Gap with the valley of Ohio and Cincinnati, ascend to 2168 feet above the level of the Atlantic ocean.

The Virginia route, after leaving the mouth of Douglass Creek, on Jackson river, rises 2551 feet, to pass into the valley of the Kanawha river.

The Maryland line from Baltimore, proposes to cross the Cumberland ridge, which is elevated 2754 feet above tide water, by a tunnel of four miles, situated 1898 feet above the ocean.

Pennsylvania has to pass her summit at an elevation of 2326 feet, with ten inclined planes, to reach Pittsburgh; yet with a broken line, of part canals and part railroads, Philadelphia draws off a large portion of the early spring business to the valley of the Ohio and Mississippi, from New York.

The line of the New York and Erie railroad, through the southern tier of counties, passes several spurs of the Allegany mountains, varying in the several ridges from 1400 to 1780 feet above tide waters. The summit on this road is situated in Allegany county, where the waters divide for the ocean by the Susquehanna, and the tributaries to the Ohio and St. Lawrence valleys.

The lowest depression in the Appalachian chain of mountains, from Alabama to Maine, is to be found in the town of North East, county of Dutchess, N. Y., on the east side of the Hudson river. This pass was discovered the laet season, on the line of the railroad from Harlem river to Albany and Troy. The ascent to the summit is only 769 feet above the Atlantic, and is through a remarkable valley, formed by the Bronx, Croton and Oblong rivers, running, with their branches in contrary directions, for near one hundred miles along the east line of the State of New York, into Columbia county. From North East, the line gradually descends to Albany and Troy, with the average rates of 16 feet to the mile, and with no grade in the whole distance to Albany [140 miles from the Harlem river,] that need exceed 30 feet to the mile, with the usual cuttings and embankments. From Troy it is well known that the Erie canal ascends gradually to Buffalo, (except for a short distance towards Schenectady,) with an average grade not to exceed eighteen inches in the mile. Lake Erie is situated 565 feet above the tide in the Hudson river—a descending line can be so located, as to defy competition with railroads to the upper lakes from any sea board State.

Massachusetts has turned her attention to the participation in the rich trade to and from the west, which now centres in Albany and Troy. She has advanced the credit of the State to the "Western Railroad" from Worcester to our State line, in the ratio of $6 to $1, to be expended by the company; following the more prudent policy which was recommended in a report of a select committee to both branches of the legislature the last winter, in preference to the purchase of the railroad of the company, or *its construction by the State.* There can be no question but that this road will be in operation from the Hudson to the Long Wharf in Boston, by the close of the ensuing year. Boston will then have accomplished her often declared design, that she will divert at least 280,000 tons of produce, merchandize, and manufactures, with the assistance of Albany and the direct trade on the closing of our canals and river, direct by the western railroad to Boston.

The elevation to be overcome by Massachusetts, at Mount Washington in Berkshire, is 1440 feet, with grades of 80 feet to the mile, to enter the State of New York. With this view of facts, derived from official reports, will the city of New York permit Boston or the north, with Philadelphia and Baltimore on the south, to run away with her early spring business? I trust not. Will she not respond to Buffalo, and not waste her energies (in the first instance,) to induce the State to commence the construction of railroads, when she can secure an uninterrupted line to Boston on the east, Lake Champlain and Ogdensburg on the north, with Buffalo on the west, with a line less in distance than any line from the sea board to the upper lakes, and without comparison, as respects grades, and elevation to pass the Allegany Mountains?

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A NEW PATENT.—Mr. Churchill, of Kane county, has invented a machine for harvesting wheat, oats and other small grain, while standing in the field, by threshing and saving the grain without cutting the straw. It has been examined by several farmers and mechanics who have pronounced it an invention of great importance to farming interests. The machinery is simple, and not more expensive than the ordinary threshing machines. It is expected to harvest and thresh at the rate of from one and a half to two acres per hour, with the power of 4 horses. Mr. churchill has taken measures to secure a patent.—*Chicago Dem.*

The arrival within our waters of the long expected Steamer British Queen, has added another bond to the union of the old and new world. We subjoin several items in regard to the size and performance of this fine vessel.

### TRANSATLANTIC STEAM SHIPS.

| | British Queen. | Liverpool. | Great Western. |
|---|---|---|---|
| | feet. | feet. | feet. |
| Length extent, | 275 | 223 | 236 |
| " under deck, | 245 | 216 | 212 |
| " keel, | 223 | 209 05 | 205 |
| Breadth between paddle boxes, | 37 06 | 30 10 | 35 4 |
| " outside of bends, | 40 | | |
| " including " | 64 | 56 3 | 59 5 |
| Depth midships, | 27 | 19 8 | 23 2 |
| Tonnage, [builders,] | 1863 | $1149\frac{1}{2}$ | 1340 |
| Tons of space, | 1053 | $559\frac{1}{2}$ | $679\frac{1}{2}$ |
| Tonnage of engine room, | 963 | 581 | 641 |
| Horse power, | 500 | 468 | 450 |
| Diameter of cylinder, | $77\frac{1}{2}$ in. | 75 | $73\frac{1}{2}$ |
| Length stroke, | 7 ft. | 7 | 7 |
| Diameter paddle wheels, | 31 6 | 28 5 | 28 9 |
| Ext. wt. engine boiler and water, | 600 tons | 450 | 480 |
| " coals, | 800 | 600 | 600 |
| " cargo, [measurement,] | 600 | 250 | 250 |
| Aft water, with the above weight, | 16 ft. 6 in. | 16 6 | 16 8 |

### ABSTRACT OF THE LOG OF THE STEAM SHIP BRITISH QUEEN.

July 12.—Sailed from Spithead at 1 P. M.—Wind W. S. W.

13th—Lat. 49 32, lon. 5 45—St. Agnes Light House N E. ½ E. 9 leagues. Distance run, 235 miles.

14th—Wind W N W to S. lat 49 34, lon 11 22—moderate and cloudy. Distance 218.

15th—Wind W N W. lat 49 23, lon 15 50—strong breezes. Distance, 181.

16th—Wind S W by W and W. lat 49 20, lon 21 18—fresh gales and squally—head sea. Distance, 210.

17th—Wind N and N N W. lat 48 6, lon 25 46—strong breezes with head sea. Distance 198.

18th—Wind N by W. lat 46 56, lon 30 10—strong breezes with head sea. Distance, 193.

19th—Wind N by W and N W by W. lat 46 13, lon 34 47, moderate breezes with swell. Distance, 198.

20th—Wind W N W. 45 30, lon 39 1—strong breezes and fresh gales, head sea—ship very easy. Distance, 182.

21st—Wind W N W. lat 45 4, lon 42 1—fresh gales with increasing sea. Distance 130.

22d—Wind W N W. lat 44 43, lon 46 27—moderate breezes. Distance, 190.

23d—Wind W S W. lat 43 42, lon 51 2—light and fresh breezes. Distance, 214.

24th—Wind W by N. lat 43 17, lon 55 40—fresh breezes and squally. Distance, 207.

25th—Wind N W. lat 42 23, lon 60 30—light breezes and cloudy. Distance, 221.

26th—Wind W and W S W. lat 41 14, lon 65 34—moderate breezes and fine. Distance, 240.

27th—Wind N and variable, lat 40 19, lon 70 35--moderate and fine. Distance, 240.

*Vessels spoken.*—July 14, spoke ship Helen, from the Azores bound to Plymouth in lat 49 32, lon 5 45. 15th, exchanged Nos. with British ship Albion. 19th, boarded the barque Bethel of Bideford, found her abandoned with all sails unbent, all running rigging unrove, all yards across, no boats, laden with railroad iron--water only up to lower deck beams, no provisions or water on board, bulkhead and lockers broken open; appears to have been plundered--and to have been deserted, for what I know not; 11 30, up and set on engines. 23d, passed several vessels at anchor, fishing on the banks. 1 30 P. M. spoke schr. Blender of Providence. 26th, spoke the Ceylon, from Liverpool to New York.

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Syracuse and Utica Railroad Celebration.----The Directors of the Syracuse and Utica Railroad Company having invited those who had taken an interest in the construction of their Road to pass over it, and participate with them in a public dinner in honor of its completion, at Syracuse, on Wednesday the 10th inst., a large party of guests from this city, including the members and officers of the Common Council, Messrs. Bloodgood and Townsend, former Mayors, Gen. Solomon Van Rensalaer, the veteran Revolutionary officer, Judge Buel, Lt. Matthew Gregory and Adjt. Gen. King, Messrs. Hawley and Benedict, Directors in the U. and S. Railroad Company, left here on Tuesday afternoon in a train handsomely tendered by Messrs. Whitney and Young, the agents of the M. and H. and U. and S. Railroads, for their accommodation.

The party having been met at Utica by the President of the Syracuse and Utica Railroad Company, left that place on Wednesday morning, with a large accession of guests, including the fine martial *Citizens' Corps*, of *Utica*, with its excellent Band, and were whirled off to Syracuse, on a Railroad, running mainly through a dense forest and over morasses and swamps which consumed but little more than a year in its construction!

At half-past eight o'clock yesterday morning we were at Syracuse, where a cordial reception from a committee of citizens was tendered. The *Citizens' Corps* wrs received and escorted in the village by a fine company of Artillery.

At two o'clock from four to five hundred sat down to a superb dinner prepared by Mr. Rust, of the Syracuse House, Gen. E. W. Leavenworth, President of the village, presided. As a full account of the celebration is to appear in the Syracuse papers, we will not attempt to anticipate them.

The U. and S. Railroad has been pushed vigorously forward. It has been constructed by the stockholders without either the aid of the State or a resort to loans. The capital is $800,000, of which eighty-seven and a half per cent has been called. It is fifty-three miles in length, and has, as will be seen, been made for twelve and a half per cent less than its capital. It is worthy of remark, that this Road has been completed within the time fixed, and has cost less than the sum estimated. For all this the public and the stockholdrs are indebted to the intelligent, enterprising and efficient services of Messrs. Wilkinson and Lee, the President and Engineer of the Company.

We rejoice to find this link in one of "the three great lines of Railroads"

thus auspiciously supplied. Syracuse, already a large, enterprising, enlightened village, is destined to become a great inland city. It possesses in its soil and its mines, "the potentiality for acquiring wealth beyond the dreams of avarice." These advantages will all be improved by an indomitable yeomanry. Syracuse is now within nine hours (150 miles) of Albany, and within nineteen hours [300 miles] of New-York. The rapidity with which we pass between these two places is amazing. We left Albany at half-past two P. M. on Tuesday, went to Utica in the afternoon, where we remained until five o'clock next morning. Was at Syracuse at half-past eight o'clock yesterday morning; remained until four o'clock P. M. and was at home this morning, breakfasting on a salmon taken from Lake Ontario night before last; having travelled 300 miles, passing a night at Utica, nearly a whole day at Syracuse, and being absent only forty-two hours!

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## LETTER TO THE SECRETARY OF THE TREASURY, ON THE HISTORY AND CAUSES OF STEAMBOAT EXPLOSIONS, AND THE MEANS OF PREVENTION. BY W. C. REDFIELD.

(Continued from page 342, Vol. VIII.)

The testimony obtained in this case was full and satisfactory. The engineers were both saved, and gave a detailed account of their proceedings previous to the disaster. The principal engineer had himself examined the state of the water in the boilers, a few minutes previous to the explosion, and there appeared to have been great care used on this point, as constituting the only source of danger. He states that the boat was stopped about two minutes at Essex, before the disaster, and he admits that he had more steam on the boilers than it was proper to use in the river, owing to the delays which had attended the progress of the boat. The engineers having full confidence in the supposed strength of the boilers, and knowing that the supply of water was complete, do not appear to have attended closely to the indications of pressure, which was, however, most accurately observed by the two firemen who were then on duty.

The pilot, who appeared a very cautious man, testified, that, after entering the river, he was obliged frequently to order the steam shut off from the engine, because he found it difficult to steer, while under full way. The steam was not blown off at Essex, except as it found its way through the safety-valve; which was loaded nominally to twenty-four pounds to the inch! although here was also a liability to error.

The most satisfactory witnesses were the two firemen, who were both saved, after having been blown into the river. They had seen but little service, but their honesty and integrity appeared altogether unquestionable. From the clear and full details of their testimony, it appeared that the pressure on the boilers at this time must have exceeded twenty-eight inches, [pounds] by the mercurial guages! During the short stop at Essex, they had both tried the water in the several boilers, and found it at the highest try-cock, of which there were four in each boiler. One fireman then crossed to the other boiler, and after renewing the trial of water there, also, they entered into conversation on these circumstances, and on the little need which there appeared for any further firing to maintain a supply of steam. They had never seen the float-roads in the mercurial guages so high as at this time. It was proven by measurement, that at a rise of thirty inches, [thirty pounds pressure,] these rods would strike the upper deck; and they testified that the rods were within three or four inches of the deck when the steamboat arrived at Essex. Other witnesses confirmed these

statements, and that the pressure had not been so great on any previous occasion.

The larboard boiler, which had shown the greatest symptoms of straining, and received most of the previous repairs, exploded a little before the other, but the second instantly followed it; owing, probably, to the tremendous shock communicated through the steam-pipes, and by which they were broken asunder; while the boilers, being alike in their structure, were both charged to the limit of their strength.

In summing the results of their examination, the board reviewed the principal conjectures or hypotheses which had been urged by manufacturers and others, in order to account for this disaster, and pointed out their inapplicability to the case before them. They then came unanimously to the conclusion, *that the explosion was caused by an excess of steam, produced in the ordinary manner.*

In this age, distinguished for experimental knowledge and exact science, it might have been expected that the facts of the above case would have been patiently sought, and considered with attention, especially by professed teachers in physical science, and by those who are directly interested or employed in steam navigation. But notwithstanding our boasted attachment to the inductive philosophy, we find too often, that opinions and hypotheses on questions of pure physics, are cherished and defended with a pertinacity which is proportioned to their incertitude and lack of evidence; for in these cases the imagination has fuller scope for the defence of its own creations. In view of the facts which have passed under our notice, it is matter for regret that engineers of long practice, as well as some men of authority in science, should have lent their aid, without due inquiry, in support of prevalent errors.

Remedies for explosions, in order to be effectual, must be derived from a correct knowledge of the facts which serve to indicate their proximate causes. It appears remarkable, therefore, that this inquiry, instituted by the owners of the New England, should be almost the only attempt at careful and thorough investigation, for the benefit of the profession and of the public, which has yet been made in our country.

It was not reasonable to expect that the report of the above examination, although supported by the clearest evidence, would convince those who had long cherished some favorite theory concerning explosions; but the comparative safety which has since attended the numerous and rapidly increasing steamboats in this section of country, may induce the inference that a real advance has been made in exploring the cause of the evil and providing its proper remedy. As within the last few years explosions are almost unknown in the New-York waters, may it not be inferred, also, that the most effectual remedy within the power of Congress, is to provide for a thorough and free investigation of all such accidents and their causes, by persons competent to this duty, without reference to judicial measures; and for the proper publication of the facts, evidence, and conclusions which may be arrived at in each case. This could not fail to afford us light on this important subject, such as would be available both to professional men and the public at large. We should then no longer grope in darkness, and our future experience would determine the question, whether persons who happen to be engaged in steam navigation are actually possessed by a species of monomania or indiscretion, which induces them wontonly to sacrifice their own lives and property, and those also of their nearest friends and fellow-citizens.

If we may rely upon the indications afforded in the above cases by the state of the metal in the exploded boilers—the most conclusive, perhaps, of

all evidence—it will appear that the most common cause of these accidents in this quarter, at least, has been the general use of boilers of insufficient strength, which have been worked under a pressure which has proved beyond the power of the boiler *permanently* to sustain. The *tenacity* of the boiler-metal is in a great measure unavailing in resisting the external pressure to which the interior portions of the boiler are subjected; and reliance must here be had chiefly upon its rigidity, which is increased in a high ratio to the reduction of the diameters. The iron boilers which have been constructed on the general plan of those of the New-England, at later periods, are more strongly braced, and in addition to the advantages of a more rigid metal, have four arches instead of two, which greatly increases their security; although a further advance in the strength of these structures is still desirable, especially in the part called the steam-chimney.

There is some reason to believe that the prejudice in favor of copper, as a material for boilers, was not eradicated from our southern cities by the experience had on the New-York waters; and that the ill-fated Pulaski, which was lost in 1838, by the explosion of her boiler at sea, was projected under this disastrons influence. That it was the design of her owners to attain the greatest degree of security, cannot well be doubted; but the accounts which I have received of the methods adopted in the construction and security of her boilers, afford grounds to infer that her actual strength was but little if at all superior to those of the New-England; and I am also informed that they had, on some occasions, been worked with a pressure of thirty-six inches, and it is confidently stated that the gauge was seen at twenty-eight inches on the night of the explosion—a practice which, if truly reported, must have arisen from the general confidence of all concerned in the adequate strength of the boilers. But the deplorable event has proved that this confidence in the supposed superiority and strength of these copper boilers had no just foundation; and the only matter for surprise, in view of such a state of facts, is, that an explosion did not sooner occur. Had the boilers been of iron, and of the same construction, it is probable that a regular working pressure could not have been obtained of sufficient intensity to have been immediately dangerous, for nearly double the amount of pressure would have then been required to produce the disruption.

### *Shipwreck of the Home.*

This subject demands our present notice only on account of the influence it may be supposed to have had upon the recent legislation of Congress in imposing a system of inspection and fees upon the hulls of steamboats. Those who are fully conversant with all the facts of the case, need not to be told of the absurdity of the current statements regarding the loss of this ill-fated vessel, though countenanced by the *ex parte* inquiry and report of a popular committee composed of clergymen and others, not professionally conversant with the matter before them, and gotten up under the greatest possible extreme of misapprehension, excitement and error.

It may not be generally known that this vessel was constructed by some of our most able shipwrights, in a manner not visibly inferior to our best packet ships, so far as may be inferred from casual inspections while building. That there were special faults in this vessel, I believe; the chief of which, I conceive to be a want of greater depth of hold, which her length seemed to require. But the chief cause why she was strained more than the other steamers which have navigated our coast, was probably owing to her *greater weight;* being, if I mistake not, heavier built than most of her competitors. From the evidence before us, I feel bound to consider the *catastrophe* of the Home as occasioned by her being volunta-

rily run on shore in the breakers, chiefly through the influence of the alarmed passengers. who were apprehensive of foundering. Immediately previous to this act, the vessel, though partially water-logged, was under the land and the gale was abating; and had she then been brought to anchor, as was the South Carolina, in similar circumstances, on the same night, it is probable that she would not have sunk, and that no lives would have been lost. But, however this might have been, this case of shipwreck, and the subsequent catastrophe of the Pulaski, seemed to have had an extraordinary influence in procuring the adoption of the scheme of legislative remedies.

It may be justly questioned, however, whether the exisiting system of naval construction as practised in this and other countries, be not radically defective. In all the heavy shocks and strains to which a sea-vessel, and especially a sea-going steamer, is necessarily exposed, the ultimate strength of the whole structure consists only in the lateral resistance which is afforded by the fastenings and their bearing surfaces. Now it is both obvious and demonstrable, that this resistance is equal to only a very small portion of the strength of the timber and materials employed in construction, and is quite unsuited to the intensely severe strains to which these floating structures are sometimes exposed.

The remedy which suggests itself consists *in the mutual interlocking of all portions of the structure which lie in contact with each other.* In adopting this method, we relieve the fastenings from the great lateral strains by which they are injured and loosened in their bearings; and the resistance is transferred to the general mass of woody material which is employed in construction, where it is productive of no injury, the fastenings being thus relieved from all other duty than holding the parts in their proper places. The superiority of this method of construction, as compared with the pegging system, ordinarily practised, and in which reliance is only had upon the lateral resistance of the wooden and metalic fastenings, is too obvious to require elucidation. A freighting vessel of 350 tons, on the Hudson, in the construction of which I have put this interlocking system in practice, is believed to exceed, in comparative strength and promise of durability, any other vessel now afloat. I consider this system of construction to be of essential importance, especially in a steamer which is to encounter the boisterous waves of the Atlantic.

### *Theories of Explosion.*

The theories or hypotheses by which explosions are commonly accounted for, usually without proper examination, and on the most vague and uncertain evidence, are chiefly the following:

1st. Injury to the boiler from heat, owing to a supposed deficiency of water.

2d. A sudden generation of steam by the affusion of water upon portions of a boiler thus heated.

3d. The supposed generation of violently explosive gases which are let off in the boiler.

4th. Recklessness on the part of those in charge.

5th. Ignorance of their proper duties in the same persons.

6th. Intoxication.

To which should probably be added as more influential than all these,

7th. Insufficient strength in the boiler for the duties permanently required of it: owing to which cause the defects of the material, insidious fractures, or deficiency in water, have become destructive; either with common or an extra degree of pressure.

It is probable, that the two first of these alleged causes have contributed to the explosion of high-pressure boilers; and the deficiency of water is always to be considered as a source of danger and of certain injury to the boiler. Moreover, the greatest care on this, and other points connected with the management of boilers, cannot be too strongly inculcated upon those in charge. But it is well known that iron boilers have, in *many cases,* been injured by a deficiency of water, under the very circumstances which are alleged as producing the most violent explosions, and that no other ill consequence has ensued than the injury to the metal. In the absence of all direct evidence, therefore, it is neither wise nor prudent, to throw the odium or responsibility of these accidents, which it is probable have mainly resulted from the general faults of the system, upon those persons who have too often perished while performing their executive duties according to their best knowledge and skill.

The theory which supposes the rapid generation of some yet undetected and highly explosive compound, is not worthy of consideration, having no other known support than may be found in a speculative fancy.

Ignorance of incumbent duties and recklessness of conduct, though sometimes found among all classes, are qualities which are not likely to obtain preference from the owners of steamboats, whose fortunes or success in business are mainly dependent upon the correct and intelligent performance of duty on the part of their agents and subordinates. In callings which are open to all classes, the only complete remedy for ignorance must be found in a more general and thorough system of popular education.

Persons who are in the habit of resorting to drugs or stimulants to keep up their vital energies, or for the gratification of a morbid appetite, are unfitted, generally, for so responsible a service as that of our steam vessels, and should never be employed, except in cases of sheer necessity. But in this species of misconduct, as in other cases, the securities afforded in construction, should be such as to prevent the consequences of this vice from becoming fatal.

The notion that boilers, under the pressure of steam generated in the ordinary way, never burst, but only rend, has no foundation in truth, and has been sufficiently refuted on various occasions.

### *Steamboat Racing.*

This subject appears to have attained an importance in public estimation to which it has no just claims. That there have been instances of misconduct attending these competitions, I have myself witnessed; and such instances are, doubtless, somewhat common. But that they are usually instrumental in putting in jeopardy the lives of passengers, is chiefly a bugbear of the imagination, which has been fostered by the public press till it passes on all occasions for reality. It does not appear to be generally understood, that the boilers of steamboats, if properly constructed, and particularly of those boats which carry large engines and work their steam expansively, are utterly incapable of generating a sufficient supply of steam to endanger the safety of the boiler while the engine is employed. The whole combination of parts in a properly constructed steam vessel is such as to allow, if not require, all the heat which can be applied to the boiler, with no other check than is afforded by considerations of economy; and the engine is competent to receive and work, with entire impunity to the boiler, all the steam which can by any means be thus generated. The entire structure is expressly designed for the attainment of the greatest possible degree of speed; and while this is aimed at, under the general

restriction before mentioned, the parties in charge are only laboring in their proper vocation; provided always, that their conduct in other respects is judicious and proper, and that the vessel be navigating in smooth water of sufficient depth.

Of the various disasters of our steam navigation, I can recollect but a single case in which the explosion of a boiler could reasonably be referred to racing, and even in this case, it is probable that the disaster only occurred a few days or weeks *sooner* than it might otherwise have done.* I would by no means become the apologist of misconduct in this or any other matter; but it is time that the indiscriminate and sickly outcry which is so often raised on this subject, should cease; for it is obvious that it can answer no other purpose than to increase the discomfort and terrors of weak and uninformed persons, or to furnish the occasion for a proscriptive paragraph in a public journal. The public have a real interest in the personal comfort and rapidity of steam navigation, which ought not to be trifled with in a senseless manner. These remarks are particularly applicable to the state of steam navigation in this quarter of the Union.

Every calling and pursuit in life is a race. The politician, the jurist, the artisan, and the mariner, all justly aim to accomplish the greatest ends in the shortest period. Why are not the enterprising commanders of our packet ships arraigned before the bar of the public, or subjected to penal enactments by Congress, for the unprecedented zeal and success with which, in late years, they have driven their ships through the waves of the Atlantic, in the face of dangers and of storms? Plainly, because those who have but little knowledge of seamanship do not attempt to control its operations.

### *Comparative Hazard of Steam in Navigation.*

So alarming have been the accidents in steam navigation on our western rivers and elsewhere, as to induce a belief in the minds of some, that of all modes of conveyance this is the most hazardous. That a degree of danger has attended this mode of travelling which ought to be lessoned or avoided, it were vain to deny; but when we reflect on the recent origin of the art, and the vast numbers of persons who are transported by its means, and when we also consider the exposure and comparative accidents of other modes of navigation and means of conveyance, this impression will be materially altered, and we shall rather have cause to wonder, that under all the circumstances of the case, so small a fraction of the travelling public have become victims to this hazard. We have, indeed, a fearful list of steamboat explosions; but the sufferings and fatalities which have attended other modes of transport and conveyance, pass off with but little notice, as common occurrences, and their statistics are seldom known. Consequently, the public mind does not become excited in contemplating these casualties, which are treated only as evils which are incident to the common lot of man

By the report of a select committee of Parliament in 1836,† it appeared that the number of English vessels lost, in a period of three years, (1816,–'18,) as collected from the books at Lloyd's was 1,203; and in a subsequent period of like duration, [1833–'35,] was 1,702. That the number of persons distinctly known to have been drowned by these vessels in the first named period, was 1,700, and in the second period, 1,714.

That during a period of 16 months, ending May 1, 1834, the loss of property by vessels reported in Lloyd's books as missing or lost, was es-

* I refer to a case on the river Ohio. † See London Nautical Magazine.

timated at 760,000 pounds sterling; and the loss of lives in the same vessels was estimated at 1,425. *These returns embrace only the losses entered at Lloyd's,* and by no means embrace the whole losses of British shipping.

It appears, also, that the *whole* loss of property in British vessels by shipwreck or foundering, is estimated at £3,000,000 sterling, annually; and the annual loss of life at sea at not less than 1,000 persons, not including the numerous losses of life on their own coast.

As regards our own navigation, which is inferior only to that of England, we find the following notice:

"*Shipwrecks in the year* 1837.—"During the year past, there has been published in the Sailor's Magazine, a monthly list of shipwrecks which have occurred, principally of American vessels, and which have been published from time to time in various newspapers. Those only have been selected which resulted in a total loss of the vessel. The number of vessels thus reported during the year, is as follows: ninety-four ships and barques, one hundred and thirty-five brigs, two hundred and thirty-four schooners, twelve sloops, and fifteen steamboats; making a total of four hundred and ninety-three vessels, which have been wrecked. Of these, forty-three were lost toward the close of the previous year, though the account was not published till the commencement of this; thirty-eight were lost in the month of January, fifty-four in February, twenty-four in March, thirty in April, nineteen in May, fifteen in June, forty-two in July, fifty in August, thirty-two in September, forty-three in October, forty-three in November, and six in December. The precise time when the remaining vessels were lost could not be satisfactorily ascertained.

"In the above named vessels, one thousand two hundred and ninety-five lives are reported as being lost. This, probably, is but a part of the whole, for, in many instances, the crew are spoken of as missing, and in other cases nothing is said, where, perhaps, there was a total loss."—[*Sailor's Magazine.*]

This statement is said to comprise no deaths by steamboats, except in cases where the vessel was totally lost. On the other hand, a very large proportion of the fatal accidents in ordinary navigation, must have escaped the knowledge of the inquirer.

Now, in view of this immense waste of life, let it be well considered, that in the art and practice of navigation other than by steam, the world has had the experience of more than four thousand years, and the efforts and intellect of many generations have been tasked for its greater security; while, on the other hand, *a quarter of a century has scarcely elapsed* since the powers of steam became prominently known in navigation, and we have as yet only witnessed the brief *infancy* of its application to this important purpose. Surely, then, it is not surprising that disastrous and fatal accidents should sometimes have attended its use. There is cause for astonishment, rather, that so great a degree of average security should have been attained, in so brief a period.

Each great district of our widely extended country possesses its own peculiar facilities and hazards in this species of navigation, and exhibits, also, different stages of improvement and security in the use of steam. In this quarter, the average degree of security enjoyed by passengers in our steamboats is certainly greater than is possessed by persons who walk the streets of our large cities. During the last five years, *millions* of passengers have been carried on the steamboats which run from this city, and, among all these, the catalogue of deaths by steam explosions is almost inappreciable.

It is probably true, that in hardly any other circumstances in which such

numbers have been placed, has the occurrence of mortality been so entirely wanting. It is with a strong sense of injustice, therefore, that those who are engaged in this important and not always profitable avocation, have found themselves selected as the objects of special and seemingly invidious legislation.

We know that elsewhere the result has been different; and much undoubtedly remains to be accomplished, in perfecting this important art, so as to render it, both here and in all other portions of our country, as secure to the traveller as can be reasonably desired. But this is plainly a practical desideratum, which can only be attained by the continued exercise of the experience and professional skill of those who may be engaged in this important department of enterprise.

### *Supposed Safety of English Steam Vessels.*

Of the various errors and opinions which have been cherished in our country, through prejudice or want of information, there is none, perhaps, which threatens to be more immediately injurious to our commercial interests, than that which ascribes to English steam vessels an almost entire exemption from explosions and shipwreck. This error would have remained unnoticed by me, had it not appeared as one of those general impressions which have contributed to the recent legislation on steamboats. It does not appear to be generally known that the principles of construction, the arrangements for security, and the general combination of parts in the English engines of the present day, do not differ in any essential degree from those which were usually adopted in this quarter previous to the year 1825; and that accidents of a serious and fatal character have not unfrequently attended the use of steam in Great Britain, both on land and in navigation.

It is a fact, also, which may not be generally known, that there has been a greater loss of life by the explosion of steamboat boilers, during the present year, [1838,] on the river Thames alone, than has occurred in the numerous and crowded steamboats which have run to and from our principal commercial city during the last five years!* And notwithstanding the contrary impressions made on the public mind by the shipwreck of the Home, and the recent appearance of several of the largest and best English steam vessels in our waters, it is also true that fatal accidents and shipwrecks have not unfrequently attended the English steam vessels. As the steam accidents in England have excited but little attention in our country, I now add such accounts and notices of accidents or extraordinary hazards to English boilers and steam vessels, as happen at this time to be in my possession. The immediate causes which are assigned in order to account for these accidents without impugning the general system of construction practised in England, may be allowed to pass for what they are worth.

### *Notices of accidents and extraordinary hazards to English boilers and steam vessels.*

1. *Loss of the Red Rover.*---In October, 1836, a correspondent of the Nautical Magazine notices "the lamentable accident of that fine steamer, the Red Rover," which appears to have sunk, in consequence of a collision with the steamer Magnet, near the Nore.---*Nautical Magazine, December* 1836.

2. *Explosion of the Union Steamboat.*---Hull, June 7, 1837. This morning at 6 o'clock, at the moment when the Union steamboat, from

* allude here to two successive explosions on board the steamer Victoria, which are mentioned in the subjoined lists, and by which more than a dozen persons lost their lives.

hence, was about to sail for Gainesborough, owing to some neglect the boiler burst; and the packet being loaded on deck with passengers, (about 120,) the mischief done and loss of life have been dreadful. Several bodies were carried over the pier into the Humber; a fishing smack picked up one body, and saw two floating down at a short distance, apparently bodies of females. One person was carried into the air the height of some sixty feet, and came down on the roof of Mr. Werterdale's mast manufactory, which is seventy to eighty yards from the place where the packet lay, and is a building forty feet high. The safety valve was blown against the office of the York packet, [a wooden shed,] about one hundred yards from the spot, with such force as to destroy one side of it.---*Nautical Magazine, July*, 1837, *p.* 474.

It was in evidence in this case, that the water ran freely from the second gauge tap, immediately previous to the explosion; that the proper weight was on the safety valve, which was lifted a moment before, and found in perfect order; and that the boiler would bear ten pounds to the square inch, but was adjusted to work with 5 1-4 or 5 1-2 pounds. The boiler had been in use less than six months. The explosion of another boat, called the *Graham*, is also alluded to in the evidence.

3. *Foundering of the Apollo steam vessel.*---About 4 o'clock in the morning of the 5th September, [1837,] the steam ship Monarch, Bain, for Leith, and the steam packet Apollo, Minter, from Yarmouth, for London, came in contact off Grays, [Essex;] the Apollo went down in ten minutes afterwards, and the stewardess and two children were drowned.---*Shipping Gazette*,

4. *Loss of the Killarney steamer.*---This steam vessel was wrecked by stress of weather on the 20th of January, 1838, on the coast of Ireland, on her passage from Cork to Bristol; and of 37 persons on board, 24 perished.---*See Nautical Magazine, March* 1838, pp. 211 and 212.

5. *Fire on board the Ocean steam ship.*---Yesterday [Sunday] afternoon, between one and two o'clock, very great excitement was created on the river, and also ashore, amongst the ship owners, by a fire being discovered raging on board the new and large steam ship, the Ocean, Myddleton, of London, lying off the custom house quay. The Ocean had just arrived from Calais, with a most valuable and extensive cargo, consisting of merchandise and goods of all descriptions; there were a great many passengers on board, and they were landed at London bridge wharf before the vessel was moored with other steamers of the foreign station, off the custom house. The flames were first seen raging amongst the larboard coal-bunkers, close to the furnaces, and by that period they must have been burning a considerable time. The engineers and firemen made every attempt to extinguish the fire, but ultimately, by the overpowering influence of the smoke, they were forced upon deck. The greatest fears were now entertained for the safety of the vessel, as the fire had extended abaft the boilers, and comnunicated to the linings. Volumes of smoke were seen to issue from the engine room and round the funnel, which rapidly increased, and the utmost confusion prevailed amongst those on board, and the vessels lying alongside. When an entrance into the engine room could not be obtained, the deck, save that portion on fire, was torn up by pole axes, and thereby access was found to the flames; the force pumps were then got to work, and in about an hour the fire was completely subdued, to the gratification of those on board, and before so much damage was done as was at first, from the appearance of the flames, anticipated. There is no doubt, had the disaster taken place at midnight, the consequences would have presented a different appearance altogether. It is believed that it must have been from

the excessive heat of the furnace, and not through the coals in the bunkers. The engines of the Ocean are of an extraordinary power, and the vessel is the property of the General Steam Navigation Company.—*English Paper, Sept.*, 1838.

6. *Disruption of the boiler of the William Stanley steamer.*----Liverpool, August 21, 1838.----Yesterday morning, about eleven o'clock, great consternation was caused at George's pier-head, by the supposed bursting of a boiler of the William Stanley, Eastham steamer, whilst lying alongside of the pier. But the truth appears to be, that the lower plate of the boiler gave way, previous to their firing up to leave the pier; and no accident was occasioned, except the scalding of the legs of a lad who was employed on board [!]----*English Paper.*

7. *Hazard of the Tweedside steamer.*----North Shields, September 15, 1838.----Intelligence reached here to-day of a very narrow escape from a melancholy disaster on board of the Tweedside steamer, on her passage from Leith to this place. She left Leith early yesterday morning, and proceeded on until she came near to North Berwick, when it was discovered that the steamer was on fire. Attempts were made for some time to extinguish the flames, but without effect. The alarm of the passengers was dreadful; when, fortunately, a London steamer came in sight, and various flags of distress were hoisted. The passengers were taken on board of the latter vessel, and conveyed to Leith, where they were placed on board of the Northern yacht, and arrived here to-day. The Tweedside was towed into Berwick, where she will receive the needful repairs. The passengers arrived here, concur in stating that, but for the providential appearance of the London steamer, all on board would have perished.----*Shipping Gazette.*

8. *Fatal steam boiler explosion.*----Another steam explosion, attended with loss of life, occurred at Halliwell, near Bolton, in this county, on Wednesday se'nnight, at the factory of Mr. W. G. Taylor, Hill mill; and we regret to say that the consequence proved fatal to a young man named Thomas Halliwell, aged nearly nineteen, an engine tender. The deceased had been four years assistant in the engine house, and was a steady, industrious workman. The boiler burst with a loud crash, destroying the engine house in a moment, and burying the deceased amid the ruins. All hands were soon on the spot, and, after removing the bricks and the stones, the body of the unfortunate man was found quite lifeless; he was dreadfully scalded and disfigured, and presented a miserable aspect. Mr. Taylor's mill being furnished with an excellent water-wheel, steam power, we understand is only used there occasionally. The boiler was in admirable condition, and the accident can be attributed to no other cause but an excess of steam, or a deficiency of water. An inquest was held the following day at the Lamb Inn, Sharples, before W. S. Rutter, Esq., coroner. The jury were of opinion that the accident had been occasioned by overfiring, in consequence of the steam being low. The death of the deceased was quite accidental, and no blame could be attached to any party.----*English Paper, September*, 1838.

9. *Dreadful steam boiler explosion.*----Newton-in-the-Willows, Monday night, September, 1838.----The viaduct foundry on the Manchester and Liverpool line of railway at this place, the property of Messrs. Jones, Turner and Evans, was this morning the scene of a dreadful and fatal steam boiler explosion. Six persons are already dead, and four others are lying without the least hope of recovery. It appears that Messrs. Jones & Co. employ about 200 men, and in the course of their business use two steam engines, one of 16 horse power, and the other of 8, to drive the blast for the smith's

furnaces. Last week a new boiler was put to the 8 horse engine, and the foreman of the yard, Joseph Dangerfield, who superintended the erection of the boiler, resolved upon setting it in motion himself. It was tried on Saturday, and was then found to work well. This morning he was called by the watchman at five o'clock, and he immediately proceeded to light the fire and get the steam up in the boiler. He accomplished this task by six o'clock; at that hour the men came to work, and about ten or a dozen of them stood at the mouth of the furnace, anxiously waiting to witness the evolutions of the engines, which had been stopped for the purpose of attaching the straps communicating with the machinery of the foundry. This had been in part accomplished, when all of a sudden the steam and water burst through the flue of the boiler, and carried the contents of the furnace and part of the brickwork full 40 yards from the building. The explosion was terrific. The bystanders and Dangerfield were carried as if by a gun shot into a field of corn on the outside of the foundry palings. The palings were knocked down, and the corn levelled to the ground for full 20 yards distance. Three of the men were picked up quite dead; their names are Joseph Dangerfield, Samuel Appleton, and George Fazakerley. John Dean was found on his knees praying to the Lord to have mercy on his soul; he lived until 10 o'clock. Thomas Price was picked up insensible; John Parker was dreadfully mutilated; William Wells, George Hough, William Dane, and ——— Wilson, were also taken up dreadfully scalded and bruised. They were quickly attended by some surgeons and a physician from Newton and St. Helans. George Hough and William Wells lived for a few hours only. Most of the sufferers are married men, with large families.

A seventh sufferer died just as our informant was closing his report. His name is Price, the father of a large family.

No cause is assigned for the accident. The exterior of the boiler still remains perfect.—*English Paper.*

10. *Extreme hazard of the Royal Tar steamer.*—We reported in the *Shipping and Mercantile Gazette* of Saturday, that the Royal Tar [steamer] had put back to Falmouth; the following particulars we take from the *Courier*:—It appears that the Royal Tar underwent some trifling repairs last voyage at Limehouse, and left the river on Friday the 12th inst, for Lisbon and Gibraltar. On reaching the Bay of Biscay she met a heavy sea and stiffiish breeze, which strained her to that degree that she was half full of water before the captain and crew were aware of it. If there had not been six pumps to go to work, she must have gone down. There were 65 passengers on board; and when it was reported that the ship was sinking, the scene of dismay and uproar that ensued, baffles description. A passenger writes as follows: "The company have got an exceedingly clever officer in Mr. Lewis, the commander of the Royal Tar; and to his presence of mind, in the first instance, and his determined conduct afterwards, do we owe our lives, and the company the safety of the vessel." The passengers have landed at Falmouth, there to await the arrival of another steamer.*

11. *Great hazard of the Victoria steamer.*—Liverpool, October 20, 1838.—On Friday last, after beating out through Crosby channel the crew of the pilot boat No. 9, saw a steam vessel, with a signal of distress up, the ensign union down, and a whiff up forward at the fore-topmast head, appearing in great distress, and in want of the assistance of the pilot boat.

* This disaster, resulting from the straining of the vessel, resembles that of the Home previous to her being run on shore, except that the severity of the weather, appears to have been far greater in the case of the Home.

At this time [half-past twelve,] the vessel was a long way to the leeward of the pilot boat. The latter made all possible sail towards her, perceiving that she was drifting down on West Hoyle bank. At two o'clock they got to her, when she proved to be the Victoria, from Liverpool for Strangford; the captain hailing the master of the pilot boat, saying that he had lost his rudder, that his pumps were choked, that all his passengers and crew were bailing with buckets to keep the vessel free, and that the water was gaining so fast as to put the engine fires out. The master of the pilot boat promptly rendered assistance, by getting two ropes from his stern, and endeavoring to steer him into safety. With difficulty, the pilot boat got hawsers from each quarter; but the sea running very heavy, with squalls, it parted both hawsers. The master advised the captain of the steamer, under this difficulty, as she had no way through the water, and was quite unmanageable, and through the indefatigable exertions of himself and crew, an endavor was made to replace the hawser, when a heavy sea struck the steamer, and hove her on board of the pilot boat, which sustained considerable damage. From thirty to forty passengers jumped on board of the pilot boat at the same moment, which placed the master and crew in an awkward situation. The master advised the captain to allow No. 10 pilot boat, which was in company, to have a hawser out from forward to tow ahead, as the night was coming on very fast. With great difficulty this was accomplished. The pilot boat had not towed more than half an hour when a very heavy squall came on, and parted the best and newest hawser which the steam vessel had on board, and the same squall parted also one of the hawsers which No. 9 had out astern steering her; so that there was only one hawser left to steer her by—the only one on board the steamer. Fortunately it held until they got into smooth water; and at 7 P. M. they came to anchor in safety near the N. E. buoy. At the request of captain Aberdeen, the pilot boat No. 9 came to anchor close astern of the vessel, where she remained until Saturday morning, when the steamer was towed in safety to the entrance of Clarence dock. Great praise is due to the masters and crews of the pilot boats for their exertions on this occasion. Had it not been for their interference, the Victoria would have been inevitably lost. No. 9 pilot boat sustained very considerable damage, and has been since undergoing repair.—*Liverpool Mail.*

12. *Upsetting of the Shamrock steamer.*—Waterford, Oct. 20. 1838.—Thursday, as the Shamrock (steamer) was coming down the Ross River, the pigs on board went all to one side, and the steamer filled. The passengers landed safely, and the disabled vessel was towed up to Waterford by the Duncannon.—*Waterford Mirror.*

(To be continued.)

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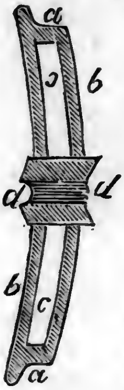
## SPECIFICATION OF A PATENT FOR CAST IRON WHEELS TO BE USED ON RAILROADS; GRANTED TO SAMUEL TRUSCOTT, GEORGE WOLF, AND JAMES DOUGHERTY, COLUMBIA, LANCASTER COUNTY, PENNSYLVANIA, MARCH 17, 1838.

To all whom it may concern, be it known, that we, Samuel Truscott, George Wolf, and James Dougherty, of the Borough of Columbia, in the county of Lancaster, and State of Pennsylvania, have invented a new and improved mode of constructing cast iron wheels for railroad cars, and for other purposes; and we do hereby declare that the following is a full and exact description thereof.

We denominate our wheel, the *Double Plate Car Wheel,* because we use two plates, instead of the spokes, or arms, usually employed, which plates are cast with the rim, and form one substance therewith. We give

to the rim of our wheels the same form in all respects as is now given to the rims of car wheels, but instead of arms we cast our wheels with two parallel, or nearly parallel, plates, which plates are convex on one side, and concave on the other; the hub, or nave, which is to receive the axle, is cast in the centre of these plates, extending from one of them to the other. The accompanying drawing gives a sectional view of one of our wheels, *a, a,* being the rim, *b, b,* the front and back plates, convex on one side, and concave on the other; *c, c,* being the hollow, or void space between them; and *d, d,* the nave, or hub. The hollow *c, c,* between the two plates is formed by a core, in the process of casting, which core is supported in the flask by leaving suitable holes in the plates for that purpose, which serve also for the removal of the sand of which the core is formed.




We cast our rim in a chill, in the usual manner, and in consequence of the particular form given to the plates, they contract in cooling without danger of fracture, and without its being necessary to divide the hub, as is done when car wheels are cast with spokes, or arms. The only effect of contraction is to flatten the two plates in a slight degree, operating in this respect like the curved arms of many cast iron wheels.

We are aware that car wheels have been made with plates as a substitute for arms, but such plates have been made separate from the wheels, and united together by screw bolts, embracing the hub in a distinct piece between them. The difference between such wheels, and those constructed by us, is so obvious as not to need pointing out.

What we claim as our invention, and wish to secure by letters patent, is the manner of constructing wheels for railroad cars, or for other purposes to which they may be applied, with double convex plates, one convex outwards, and the other inwards, and an undivided hub; the whole cast in one piece, as herein fully set forth.

SAMUEL TRUSCOTT,
GEORGE WOLF,
JAMES DOUGHERTY.

[*Journal of the Franklin Institute.*]

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MORE "RAILWAY MISERIES."---A new disease appears to have broken out amongst railway travellers, in consequence of the velocity of speed. A gentleman of great experience in the old way of travelling, who resides not twenty miles from High-lane observed to us the other day, that this disease will in time completely upset the intellects of such of her majesty's subjects as are so unfortunate as to adopt this expeditious way of "whirling their bodies" from one end of the kingdom to the other. The worthy gentleman above alluded to offered to make a considerable wager, that he would take his stand in Market street, Manchester, and could instantly find out from the passengers in that thoroughfare, all such of them as had just left the railway, and were proceeding to business. He describes them as being so full of speed and motion, that though they are mounted on their own pedestals in the streets, yet they fancy they are still on the railway, and like the merchant of Rotterdam, with his cork leg, unable to control their speed. He asserts that he actually saw one gentleman so full of velocity, that in attempting to turn the corner of the Royal hotel, to get into Moseley street, he ran his head against one of the gas lamp posts, and broke the iron pillar to shivers. Most men would have thought that the head would have broke, but such was not the fact, as could be abundantly proved by many persons on the spot. The anti-railroad gentleman further stated, as a fact notorious, that many persons had confessed to him, that they had

frequently gone to Liverpool and London on the railway, and from the extreme velocity of travelling had forgot what they went for, and had actually to write to their Manchester friends to be informed what they went to town for. The subject appears to demand the serious attention of "philosophy," and all professors of the infancy, and preserve to our fellow countrymen what little sanity they may have left since the passing of the reform Bill. Her majesty's ministers are infected by the rapid railroad method of legislation, as may be satisfactorily proved by the sagacity and integrity of their proceedings.—[*Stockport Advertiser.*]

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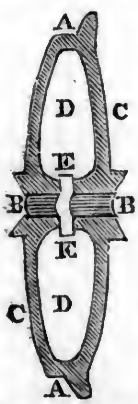
SPECIFICATION OF A PATENT FOR AN IMPROVEMENT IN THE MODE OF MAKING CAST IRON WHEELS ROR CARS, TO BE USED ON RAILROADS. GRANTED TO JONATHAN BONNEY, CHAS. BUSH AND GEO. G. LOBDELL, WILMINGTON, NEW-CASTLE COUNTY, DELAWARE, MARCH 17TH, 1838.

To all whom it may concern: Be it known that we, Jonathan Bonney, Charles Bush, and George G. Lobdell, of Wilmington, in the county of New-Castle, and State of Delaware, have invented an improvement in the manner of constructing cast iron wheels for cars, to be used on railroads, and for other purposes; and we do hereby declare that the following is a full and exact description thereof. The accompanying drawing shows a section of one wheel, which, instead of arms as usually employed, has each face thereof convex, a hollow space being left between the two surfaces.




The rim of the wheel A, A, does not differ from those usually employed, and is cast in a chill in the ordinary manner. The rim is united to the centre, or hub, of the wheel B, B, by the two convex faced plates C, C, which are cast in one piece with the rim and hub. The interior D, D, between the two convex face plates, is formed by cores, supported in a way well known to iron founders. The hub has a transverse division E, E, which separates it into two distinct parts, attached respectively to the face plates. This division is necessary to prevent the tension which would be produced by shrinkage in the casting, and which would endanger the breaking of the wheel. The hub, if preferred, may be cast solid, with the exception of the division E, and afterwards bored out; or it may be cored and turned to receive the axle.

We are aware that wheels have been made with double convex plates, both of cast, and of wrought iron; but such plates were in separate pieces from the rims and hubs, being received into rebates on the rims, and embracing the hub between them, which extended through openings in their centres, the two plates being secured together by screw bolts; we are also aware that a plan has been devised for casting iron wheels with two face plates, having a space between them formed by cores, as in our method, but the two plates were in this case parallel to each other, one of them being convex, and the other concave, on its face, the hub extending from one face to the other in a continuous piece, rendering it necessary, on account of shrinkage, to place the two plates as described; an arrangement which sacrificed strength to necessity.

By constructing the wheel so that the plates shall both be convex outwards, as they are, in the position of the greatest strength, they may be made considerably thinner than would otherwise be admissible, and the wheel will consequently be lighter.

All that we claim as our invention, is the division of the hub into two parts, transversely, between two face plates each convex outwardly, in the manner, and for the purpose, set forth.—*Jour. Franklin Inst.*

# AMERICAN RAILROAD JOURNAL, AND MECHANICS' MAGAZINE.

No. 2. Vol. III. New Series. | JULY 15, 1839. | Whole No. 338. Vol. IX.


AN ESSAY ON THE LAWS OF TRADE IN REFERENCE TO THE WORKS OF INTERNAL IMPROVEMENT IN THE UNITED STATES. BY CHARLES ELLET, JR. CIVIL ENGINEER. CHIEF ENGINEER OF THE JAMES RIVER AND KANAHWA IMPROVEMENT. RICHMOND, 1839.

Nothing can be more welcome to the friends of Internal Improvement, than the establishment and elucidation of the principles which govern the trade of public works. While other subjects connected with the duties of Civil Engineering have been handled by those who could bring to their aid the light of exact and natural science, this most important topic, admitting the most exact investigation, has either been neglected, or else declaimed upon as a branch of the too often imaginative science of political economy.

The above named work of Mr. Ellet has complied most faithfully with the requisites for such an undertaking. His investigations, thus sustained by strict mathematical reasoning, are within the comprehension of every one who has mastered the elements of algebra, and thus possesses all the strictness and beauty of development belonging to such a mode of treating the subject, while the simplicity of the language is rather increased than diminished by the preference of the mathematical form of expression. A cursory examination of the work, has led us to entertain very high opinions of its value, not only as tending to settle some of the most important principles of Internal Improvement, but as introducing a most excellent method of conducting such investigations. We have always desired to inculcate more exactness than has hitherto obtained in the treatment of such subjects, for it is sometimes held up as a reproach to the profession in this country, and most unjustly too, that we are particularly inerrent in our notions on topics admitting of great exactness. We therefore welcome with pleasure, the publication of a work showing that neither our notions nor our modes of expressing them, are of this inerrent stamp—and proving that if such an essay is written, as the author says, amid the thousand cares of

the charge of a work progressing under a force of 4000 men, and of a survey of a line of 300 miles in length, it is not only an excuse for the scarceness of such works from our civil engineers, but a cause of admiration for the neatness with which the present volume has been brought out.

We cannot but bear evidence to the extraordinary beauty of the typographical execution of this useful work, rendering it a pleasure to peruse it.

We should have previously noticed this treatise, but have accidentally been deprived of a sight of it until quite lately.

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For the American Railroad Journal and Mechanics' Magazine.

ON THE TRUE EXPRESSION OF THE POWER, VELOCITY, ETC. OF LOCOMOTIVE ENGINES: BY W. M'CLELLAND CUSHMAN, CIVIL ENGINEER.[1]

*Gentlemen:*—On perusal of Chev. De Pambour's work upon locomotive engines, I noticed a disagreement between velocities computed from his general formula and those determined by experiment, in an instance or two, in which the diffierence was very decided. As the *formula alone* could make his experimental results *available in practice,* I was induced to make an extended comparison between the formula and actual trial, when I became satisfied the difference was not incidental, but effected *all the results,* in a greater or less degree. This surprised me not a little, as every page of the work evinced capabilities in its author adequate to the profoundest researches—who, moreover, had neither excluded, or left uninvestigated, any of the *usual elements* of the question. Hence the conclusion was forced upon me, that some essential element or elements had hitherto been omitted by engineers—and for my own satisfaction I set about an investigation, and was successful in discovering them, as well as the laws which they obeyed; when, of course, there was no difficulty in involving them in a new formula, which I did for my own professional use and guidance. This has quietly reposed among professional memoranda without any attempt, perhaps I may add, intention, on my part, of publishing it, partly impelled for want of leisure, [having engagements which claimed my attention at the south] and partly wishing to avoid a critique [possibly the worse excuse] upon a work which every engineer will concede to be a boon to the profession of transcendent usefulness, though its distinguished author *failed to complete the superstructure* for which he had laid so exquisitely proper a foundation, in his beautiful series of experiments.

At present I have leisure; and am the more willingly induced to break through the restraints I had imposed upon myself, inasmuch as the formula in question has been attacked by several engineers, and been defended with much ability by his friends. It is sufficient, however, that *neither of the points where my researches lay the default, have been investigated;* and *that the actual powers of the engine have, in consequence, never yet been expressed.* So much for criticism—now to the proof. The formula of de Pambour is, [see pp. 189, Lond. ed.] $v = \dfrac{m c \cdot p}{55\left\{\frac{2}{3}\varphi + \dfrac{5d^{4}lx}{D}\right\}}$

expressing all quantities in inches except the evaporating capacity $c$, which is feet, and putting $\varphi$ = the friction and gravity of the engine and train in lbs. avoirdupois—for the convenience of using my notes, of which the sequel is nearly a literal duplicate; and the following is an abstract of De Pambour's *experiments* upon the Liverpool and Manchester railroad, with the *corresponding results of this formula*, in a tabular form, [I subjoin dimensions of the engines, the pressure, &c., that the calculations may be made by those who feel interest enough in the subject to repeat them,] viz :

| Number. | Designation and Dimensions. | | | | | | Gravity in lbs. | Speed miles per hour. | | Error per cent. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Name of the Engine. | Load in Tons. | $l.$ in | D. inch | $d.$ es. | $p.$ in lbs. | | By experiment. | by the formula. | | per cent. | |
| 1 | Atlas. | 127.6 | 16 | 60 | 12 | 68. | —2.05 | 17.1 | 18.9 | .10 | | |
| 2 | | 195.5 | | | | 70. | 1.72 | 8. | 10.5 | .31 | | |
| 3 | | — | | | | 68.½ | 0. | 9.2 | 12. | .30 | | |
| 4 | | 66.7 | | | | 48.½ | —2.05 | 21.8 | 25.7 | .18 | | |
| 5 | | — | | | | — | 0. | 20. | 22.3 | .11 | | |
| 6 | | 40.1 | | | | 40. | —1.72 | 23. | 29.0 | .26 | | |
| 7 | | — | | | | 66. | 25.2 | 7.5 | 11.8 | .57 | .26 | mean |
| 8 | Fury. | 38. | 16 | 60 | 11 | 67. | 0. | 25. | 33.7 | .35 | | |
| 9 | | — | | | | 69. | — .52 | 25.7 | 34.6 | .30 | | |
| 10 | | — | | | | 68. | —1.72 | 26.9 | 37. | .38 | | |
| 11 | | — | | | | 67. | 2.64 | 24.6 | 29.2 | .19 | | |
| 12 | | — | | | | 69. | 25.2 | 13.3 | 14.0 | .05 | | |
| 13 | | — | | | | 67. | 2.05 | 24.8 | 30.3 | .10 | | |
| 14 | | 56.2 | | | | 70.½ | 1.72 | 21.8 | 25.8 | .18 | .22 | mean |
| 15 | Vesta. | 94. | 16 | 60 | 11⅛ | 68. | — .52 | 18.4 | 21. | .14 | | |
| 16 | | 48.7 | | | | 67. | 0. | 24.0 | 33.7 | .40 | .27 | mean |

These tabular statements and results prove, very conclusively, that the formula *does not agree with experience*, departing, in every instance cited, more or less, by an amount averaging for each engine from 22 to 27 per cent., and ranging frequently much higher, sometimes even to 57 per cent. ! *Note a.* Certes, then, nothing gratuitous has been predicated, enough being here exhibited to establish clearly my position, that the *formula cannot be depended upon.*

But can a good solution be effected ? I answer yes—and rest the assertion upon the subsequent discussion of *certain neglected considerations* which are indispensable.

Now one circumstance exhibited in this table is very striking: the *calculated velocities all range above their real values* determined by the experiments, which implies an omission of some important resistances—and proves that it is *not sufficient to allow for the influence of friction and gravity.* Before a formula will express true results, this resistence, at least, must be brought into it. But there is besides an important *principle* which has been entirely overlooked in its construction; and, singularly enough, this is to be found in the one or two chief points which distinguish the modern from the old time locomotive, viz, using up the steam after it has operated upon the pistons, to advance the combustion—thereby gener-

ating, in a given time, a greater quantity of steam than is possible without the arrangement, and, of course, increasing it with the speed.

Yet, though [as will appear] so very large a share of power is derived from this principle, and the fact is so obvious as constantly to present itself to observation, its influence has been ever and perseveringly overlooked in calculations—no *attempt*, even, having ever been made *to discover the relative degree of evaporation as the speed is advanced or retarded.* Here then, is another point *affecting* the *intrinsic power of the machine*, to be added to the omitted resistance, and these, together, will account for the remarkable deviation of the deductions of the formula from the actual trial as when allowed for, the results of experience may be anticipated, *a priori* by calculation, with precision. As to this latter principle, an experiment upon the Atlas gave these results—with an average velocity of 8.99 miles per hour, the evaporation was 40.25 cubic feet per hour; and the mean of two other experiments upon this engine [made at nearly equal velocities] is 15.26 miles and 47.4 cubic feet of water evaporation. The exponent of the power of $v$ is then very nearly 1-3—that is, the quantity of water raised into steam in a given time, is *as the cube root of the velocity of the engine.* Those of the other experiments that can be confided in, confirm this result very precisely: or if varied according to this ratio, the deduced results will agree with the experimental values: this, then, must be regarded as a *general law inseperable from the locomotive engine of modern construction.*

Suppose, now, the evaporating power of an engine has been found, at--say 19 miles per hour: at 5 miles it will generate but 64 per cent. of that quantity, while at 40 miles it will raise 128 per cent. of the same quantity into steam--which is *double that at 5 miles*--for $\left.\overline{\frac{5}{19}}\right|^{\frac{1}{3}} = .64$ and $\left.\overline{\frac{40}{19}}\right|^{\frac{1}{3}} = 1.28$, and *the motive power of the steam, is precisely in the same proportion.* An error of 100 per cent. within the practicable range of the velocities, being thus shown to be *inevitable* when this law is neglected, an *invariable length of stroke*, or *diameter of operative wheels* might with as much propriety *be assumed, as that the evaporating power is constant.*

Now the mean generation at 19 miles, has been accurately determined [designated by $c$ in the formula] and at any varying speed the corresponding generation will be $c\cdot\left.\overline{\frac{v}{19}}\right|^{\frac{1}{3}}$ cubic feet per hour. When then, this is allowed for, the equation becomes

$$v = \left.\overline{\frac{3\,m\,c\,p}{440\cdot\left\{\frac{2}{3}\varphi+\frac{5d^2lx}{D}\right\}}}\right|^{\frac{3}{2}}.$$

From the manner in which $c$ varies with the velocity it is evident that when the speed is greater than 19 miles the generation will *exceed*, and when less than 19 miles it will *fall below*, its mean value at that speed. Hence the results computed from this expression will come out sometimes higher and sometimes lower than by De Pambour's—the two agreeing only

at one point, 19 miles, but his formula gives in all the instances, results much higher than can be attained in practice: at high velocities, therefore, the last expression will evidently *increase the deviation*, while at lower speed, it will approach gradually nearer the real state of things than the Chevalier's. As yet, then, only a partial solution is obtained, after allowing fully for the effects of this principle.

Now, another circumstance peculiar to this expression is this: its results *diverge* gradually more and more as the speed is raised—some *variable* resistance to the motion, therefore, *yet remains to be estimated*:—this is the resistance which was previously noticed. But as every *inherent* resistance of the engine and train in convoy has been allowed in its full and proper extent, that only which answers to the indications of the formula, is the *external resistance of the atmosphere*---which suits those conditions precisely, as its effects *vary with the velocity.*

It would be easy to allow for this, *a priori*, if the exact extent of plane superficies presented by the various parts of the engine were given. But how estimate the force of the wind upon a tree with its myriad limbs? and the case seems a good parallel to an attempt to define the flat surface equivalent to those of the boiler, frame, rods, smoke stack, &c., of an engine. Perhaps this is the reason why engineers have always neglected a resistance which is known to be considerable at even moderate speeds: how else do a few yards of canvass presented to the gale, plough, for the stately ship, its way upon the deep---a feat that engines of some 500 horse power are scarce able to accomplish? Now, the motion of a locomotive, in reference to the atmosphere, *in its quiescent state*, answers to the speed of the wind in the former---*opposing* the passage of a locomotive in proportion to its speed and surface presented, precisely as the wind *forces* onward the ship in proportion to its velocity and the surface of her sails; and I do not see the necessity of attempting to estimate *directly* the amount of surface, for if $a$ = force in *lbs.* upon a unit of the surface $s$, when the speed is $v'$, the total resistance to motion in *lbs.* will be $a\,s\frac{v^2}{v'^2}$ with the variable velocity with which the engine works, after refering this to the piston it may evidently be introduced into the formula among the other resistances. Now $a$ and $v'$ are known *a priori*, and the entire co-efficient $\frac{a\,s}{v'^2}$ is constant. I therefore take an experiment in which all the other quantities are given, and resolve the equation in reference to this constant co-efficient, *note b*, the result is placed instead of it in the general equation. In this way the atmospheric influence is truly provided for without any knowledge of the actual surface presented---this done, my final equation is,

$$\sqrt[3]{v^2}\left\{v^2+2\cdot5\sqrt{\tfrac{2}{3}\varphi+\frac{5d^2lx}{D}}\right\}=\frac{3\,m\,c\,p}{176}$$

an expression based entirely upon experimental results, and which, there-

fore, will now agree with experience. In further illustration, in a practical way, of the correctness of its principles and its analysis, I beg leave to present again the list of experiments detailed in the opening of this paper, in comparison with results calculated by this formula: viz.

| Number. | Velocities. | | Number. | Velocities. | | Number. | Velocities. | | Error per ct. |
|---|---|---|---|---|---|---|---|---|---|
| | By experiment. | By calculation. | | By experiment. | By Calculation. | | By experiment. | By calculation. | |
| 1 | 17.1 | 17.1 | 8 | 25.0 | 25.9 | 15 | 18.5 | 18.9 | |
| 2 | 8.0 | 7.5 | 9 | 25.7 | 26.4 | 16 | 24.0 | 23.3 | |
| 3 | 9.2 | 9.5 | 10 | 26.9 | 27.6 | means. | 21.25 | 21.10 | .01 |
| 4 | 21.8 | 21.9 | 11 | 24.6 | 24.0 | means. | 23.10 | 23.03 | .01 |
| 5 | 20.0 | 19.7 | 12 | 13.3 | 11.5 | means. | 15.23 | 15.36 | .01 |
| 6 | 23.0 | 23.5 | 13 | 24.8 | 24.5 | | | | |
| 7 | 7.5 | 8.3 | 14 | 21.8 | 21.3 | | | | |
| means. | 15.23 | 15.36 | means. | 23.10 | 23.03 | | | | |

The *average* deviation for *each engine* by the formula of the Chevalier [see first table,] ranged from 22 to 27 per cent. above those of experience: in the last table, the departure from the experimental averages of each engine, is *never as much as one per cent.*—a deviation which, besides being "too trivial for accompt," will be viewed by those, who, like the engineer, have occasion to apply grand and comprehensive principles to practical purposes, as proof that the coincidence is in no-wise accidental: and the more extraordinary, as he seldom has to do with powers so subtle and variable, or resistances equally complex and evasive.

The equation of the maximum load is so easily derived from my general formula by the scientific engineer, that it need not be discussed; and I will only further remark, that the engines of the Liverpool and Manchester railroad, which furnished these experimental results, all operate upon the principle of *exhaustion;* there is no reason, however, why these principles are inapplicable to engines operating with a *direct blast,* which is but the converse of the other. For instance, the engines of the Baltimore and Ohio railroad have a blast, and differ besides in the disposition of the boilers, the kind of fuel, &c. Mr. Knight, the chief engineer of the road, found that the Arabian, drew upon a level, a gross load of 112 tons $18\frac{1}{4}$ cwts., at the speed of 11.79 miles per hour—by the formula it comes out 11.7+ differing *less than one per cent from the actual trial.* This, besides, is an interesting fact, as it proves conclusively, that we have engines in this country, purely American in plan and construction, at least equal to the best European. It is to be regretted, that so few of the trials meant ostensibly to show the powers of our engines give sufficient details to infer their real performance, nearly every attempt omitting some essential fact. This, by the way, is so important, that I will take leave here to suggest, that unless *all the quantities involved in the formula,* are distinctly and precisely stated, it is impossible to form any true idea of what an engine has really done.

**Albany, August 13th.**

*Note a.* **The** list of De Pambour's experiments furnishes much greater devia-

tions *than even the highest of this table.* It would, however, be unfair to quote results which were evidently affected by some casual perverting circumstances: such of the results of each sett of trials as were *inconsistent among themselves,* have accordingly been rejected. For instance, 16th July the Atlas made 15. miles per hour upon a level grade, and with same load upon an *ascending grade* it made 22.6 miles per hour, which is manifestly absurd. Here, probably, the engine had not got up steam upon the *starting level grade.* So with the Fury, under similar circumstances, 24th July. In some instances, the wind produced evident anomalies—witness, Vesta, 1st August: in others, the engine was out of order; and so, again, there are very remarkable deviations which I refer to insufficient adhesion. These are all *accidents,* having nothing to do with the real performance of engines, or their daily routine of duty.

*Note b.* This co-efficient comes out .4 very nearly: at 30 miles per hour, therefore, $4\ v^2 = 360$ *lbs.* is the force with which the atmosphere opposes the motion of the engine, which is the trackage of 45 tons upon a level, or 10 cars fully laden! How absurd, then, are those deductions where the atmospheric influence is rejected?

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## Railway fares.

(Continued from page 14.)

"The following statements will show how far the Belgian surpasses the English railroads in cheapness of fares. In the former country there are four classes of carriages, the cheapest of which is only 2-7ths, or less than one-third of the English, and only 4-10ths of a penny per mile. In England there are sometimes not more than two classes, the lowest of which bears a very different and a much higher proportion to the superior carriages. The Manchester and Liverpool railway affords a favorable opportunity of comparison, as the distance is about the same as that between Brussels and Antwerp; the former being about 30 miles and the latter 27 1-4 miles. The fares are as follows:—

| *Liverpool and Manchester,* 1837. | s. d. | *Brussels and Antwerp,* 1838. | s. d. |
|---|---|---|---|
| Mails | 6 6 | Berlins | 2 11 |
| Coaches | 5 6 | Diligences | 2 6 |
| Wagons | 4 0 | Chars-a-banc | 1 8 |
| | | Wagons | 1 1-2 |

"On the English line, therefore, the lowest class is nearly two-thirds of the highest, and the rate per mile for the lowest class is equal to the rate of the highest on the Belgian lines, viz:—

| *Liverpool and Manchester.* | | *Average of Belgian Lines.* | |
|---|---|---|---|
| Mails | 2 1-2*d.* per mile. | Berlins | 1 1-2*d.* per mile. |
| Coaches | 2 1-8*d.* " | Diligences | 1 1-4*d.* " |
| Waggons | 1 1-2*d.* " | Chars-a-banc | 3-4*d.* " |
| | | Waggons | 1-2*d.* " |

The writer proceeds to offer a comparison of the present amount of travelling in England and Belgium, observing:—

"The Liverpool and Manchester Railroad offers a very favorable com-

parison for this country, as the intercourse between those two towns is perhaps greater than between any other two places at an equal distance. The number of passengers booked at the Company's offices on that line since its opening has been as follows:—

| | | |
|---|---|---|
| In 1830 | (from the 16th September to the 30th December,) | 71,951 |
| 1831 | (the whole year) . . . . . . . . . | 445,047 |
| 1832 | " . . . . . . . . . . | 356,945 |
| 1833 | " . . . . . . . . . . . | 386,492 |
| 1834 | " . . . . . . . . . . | 436,637 |
| 1835 | " . . . . . . . . . . . | 473,849 |
| 1836 | " . . . . . . . . . . | 522,991 |

"The population of the towns on this line, exclusive of the adjacent districts, which teem with inhabitants engaged in commerce and manufactures, was in 1831—Liverpool, 196,694; Manchester, 270,963; Warrington, 19,155; total, 486,812. This number could not have been less in 1836 than 523,000, which is the number of passengers using the railroad in that year. On an average, therefore, each inhabitant may be supposed to take one trip in a year.

"In Belgium the number of passengers booked at Brussels, Mechlin, and Antwerp, inclusive of two intermediate stations, in each year since the opening of these lines has been as follows:—

| | *Brussels.* | *Mechlin.* | *Antwerp.* | *Total.* |
|---|---|---|---|---|
| 1835 [8 last months] | 215,342 | 206,097 | | 421,439 |
| 1836 [Antwerp only 8 months] | 379,588 | 265,048 | 226,671 | 871,307 |
| 1837 . . . . | 475,155 | 364,317 | 305,995 | 1,145,467 |
| 1838 [10 months] . . | 511,326 | 338,351 | 299,146 | 1,148,823 |

"The population of these three towns did not in 1838 amount to one-half of that on the English line, namely, Brussels with its surburbs, 134,302; Mechlin, 22,895; Antwerp, 75,363; total, 232,960; and neither the population nor the commercial activity of the surrounding districts can be compared with those of its competitor, yet the intercourse in 1837 was more than twice as great; and with reference to the difference of the population was five times as great, the average number of trips to each inhabitant having been five per annum. A comparison with the intercourse on both lines previous to the formation of the railroads is equally favourable to the Belgian undertaking. On the Liverpool and Manchester line the average number of passengers which the coaches carried in the year 1825, was estimated at 450 daily, or 164,250 per annum. The number actually conveyed by the railroad in 1836, was 523,000, showing an increase of 218 per cent., or rather more than three times the former number; the fares having been reduced from 10*s.* and 6*s.*, to 5*s* 6*d.* and 4*s.*; the higher rates one-half, and the lower only one-third. On the Belgian line the number of passengers between Brussels and Antwerp, before the opening of the railway, is said to have been 80,000 yearly. The rates of conveyance have been reduced from 4*s.* and 2*s.* 6*d.* to 2*s.* 6*d.* and 1*s.* 01-2*d.*; the higher fares two-fifths, and the lower three-fifths; and in 1837 the number of passengers booked at Brussels and Antwerp, excluding Mechlin, whence a portion of the passengers were proceeding on other lines of railway, was 781,250, showing an increase of 876 per cent., or about nine and a half times the former number. If Mechlin be included, the increase will be fourteen times the former number. An analysis of the classes of travellers will show that this superior activity is in a great measure owing to the cheapness of fares. Of the total

number of passengers during the six months ending 30th of October, 1836, the proportion using each class of carriages was as follows:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Berlins, paying | 2*s.* 11*d.* | 1.7 | per cent., | yielding | a revenue | of 5 | per cent. |
| Diligences . | 2*s.* 6*d.* | 3.7 | " | " | " | 9 | " |
| Chars-a-banc | 1*s.* 8*d.* | 22.2 | " | " | " | 32 | " |
| Wagons . | 1*s.* 0½*d.* | 72.4 | " | " | " | 54 | " |
| | | 100 | | | | 100 | |

The proportion of persons travelling short distances only in wagons is still greater, but the above is sufficient to show how large a portion of the whole revenue of the company is derived from passengers of the lower class paying a very small fare; and it is a just inference that the high rates of fares on the Liverpool and other railroads in England do very materially check travelling; that to the artisan they entirely prohibit travelling for pleasure; that they restrain even the wealthy in the use of this source of recreation; and it can scarcely be doubted that they interfere with journeying on business. Whether an increase of numbers at a low rate would repay the corresponding additional outlay for locomotive power, wear and tear, &c. is another question, upon which the evidence afforded by the Belgian Railway is also important. The following result of the operations on all the lines since they were severally opened, tends to show that the experiment has been successful:—

| | | | | *Expenses.* | *Receipts.* | *Excess of Receipts.* |
|---|---|---|---|---|---|---|
| 1835 | 1 section open | 8 months | | 6,748*l* | 10,756*l.* | 4,008*l.* |
| 1836 | 1 " | 4 " | | | | |
| | 2 " | 8 " | | 17,244 | 33,004 | 15,760 |
| 1837 | 3 " | 6 " | | | | |
| | 8 " | 4 " | | 46,216 | 56,676 | 10,460 |
| 1838 | 6 " | 3 " | | | | |
| | 8 " | 4 " | | 64,768 | 105,340 | 40,572 |
| | 10 " | 3 " | | | | |

The cost of these ten sections, including the materials, was about 1,360,000*l.*, the interest of which sum, at 5 per cent. per annum, would amount to 68,000*l.*; and for ten months, to compare with the above, it would be 56,667*l.* But it must be borne in mind, that the whole of the ten sections were only in operation during three months, and therefore the profits of 1838 must not be charged with the cost of all the sections. The receipts at Ans, which section was only open seven months, amounted to nearly one-third of those at Brussels during ten months, and the line from Bruges to Ostend was not open three months. The following were the receipts at each principal town:—

| | |
|---|---|
| Brussels | 29,882*l.* |
| Antwerp | 16,553 |
| Ghent | 13,114 |
| Mechlin | 11,640 |
| Ans | 9,571 |
| Louvain | 7,728 |
| Tirlemont | 4.218 |
| Ostend | 1,607 |
| Other towns | 11,027 |

This statement sufficiently indicates the favourable prospects of the undertaking.

### THE CENTRAL AND OTHER RAILROADS.

While many of the schemes of Internal Improvement, throught the Union, are confessedly falling to the ground, or have already perished, it is cheering for Georgia, to turn to her great work, the Central Railroad, and have the satisfaction to know that it has progressed beyond all comparison.

No work of the kind ever was attempted without doubts and misgivings on the part of some exceedingly wise persons—who always know more than their neighbors—especially if they are so extremely disinterested, as not to embark a dollar in the enterprise. Then, of course, their words are cheap and they can speak with freedom. These kind of people, like other folks, have generally *two* eyes—but one of them is an envious one, and with it they can see nothing profitable or patriotic in which they are not themselves immediately concerned. "Croakers" are proverbial, and sensible men treat them as BENJAMIN FRANKLIN did, when old BRADFORD endeavord to dissuade him from commencing the printing business in Philadelphia. The "Croakers" of the Central Railroad project, however, having seen all the difficulties they prognosticated vanish before time, are nowhere to be found—or have abandoned their vocation.

The Central Railroad is now in operation upwards of 80 miles. It is daily shortening the distance between this city and our flourishing sister of the interior—Macon. The day is not far distant when a few hours travel will make us one people. Macon must ever be an *entrepot* for the cotton of the interior of Georgia; but there are other commodities not so bulky as that valuable material, to which we must soon look to the upper regions of Georgia for a supply. It is a fact that more grain has been raised in this State last season, than was ever produced in Georgia before. In some of the midland counties, we understand that fine flour can be had at the rate of $3 00 per cwt. at the mills—superfine at $3 50. This spring the farmers in the Up Country, have gone larger into the cultivation of grain, than they did last—so that we hope to see the day when the Savannah market will be entirely supplied with Georgia flour. Corn and Bacon, these "staffs of life," will also find their way here—and butter and cheese.

Really, we should be ashamed of ourselves, as Georgians, to have slept so long, and paid so heavy a tax for what we could have raised ourselves—but, moreover, for permitting the vast natural advantages of our State to remain without assistance, and without application. But the ice is now fairly broken, and the stream of Internal Improvement has overflowed and carried with it all barriers—never more to be blocked up by the chilly and freezing air of neglect. Let it roll on, until it has fertilized the woodland and the plain! Let the mighty tide never cease to flow, until Georgia takes her station amongst her sisters of the Union—and holds her beauteous head as high as the proudest!

Let us contemplate for a moment the scene that may be when the Central Railroad is completed to Macon—when it reaches, by means of the intersection at Waynesboro', Augusta. Then will Savannah, the seaboard of the State, have at least a fair chance of becoming what she should be, the emporium of the South. The merchants of Macon and Augusta, can visit our city in one day, and return to their homes the next. The trains of cars laden with the produce of Georgia, from the cities we have named, will glide along our road, and be transported to our storehouses or wharves in a few hours. Hundreds who would never leave home, when the journey would be two or three weeks in duration, will lay aside for a day, their cares, and visit the large cities of their native or chosen State, to see and

be seen, and to become acquainted with their fellow-citizens, who reside in other places.

Our cities will be thronged—our people will be employed, and industry and enterprise will obtain a certain reward. Other improvements will be made throughout the country, especially in the neighborhood of the railroad or its branches. The people in those quarters will wake up, and catch the spirit of improvement as it flies along. We will be a prophet for once, and augur that the people of Georgia will bless the day, when the project of the Central Railroad was first started—and posterity will honor and revere its authors.

Our readers will see that a small profit is derived already from the stock, before the work is half completed. A dividend of one dollar per share has been declared by the Company *from the profits* of the railroad.

It is not, however, the above project alone, that will enrich our State. The Georgia Railroad Company, an abstract from the Engineer's report of which we gave the other day, is in a most flourishing condition. It will soon be completed, and will pay its stockholders well, and be a vast benefit to Georgia.

The Monroe railroad, too, is doing well. We believe it has fully come up to the expectations of its projectors; and the connexion of Macon and Forsyth, effected by this road, is all important, to keep up the chain of railroads, from the seaboard to the mountains.

The Great State road from the Tennessee, is also in a proper train. We append the last report of the Board, which it will be seen, is very flattering.

Having thus made a brief sketch of the present and future prospects of Georgia, connected with Internal Improvement, we may ask, will the next legislature be prepared to enter into the spirit of the day? Will it lend the credit of the State to works that have proved beyond all doubt, their practicability—their advantage? Time alone can determine this question—but the weal or woe of Georgia, is, as yet, in the hands of the people. They have the selection. Let them make a good one.

No man is worthy of the station of a representative of the people, who will allow sectional or unworthy feelings, to interfere with his duty as a legislator. Let the citizens of Georgia, see whether they have sent such men to the General Assembly before, and if they have, let them make amends, by scouting their pretensions now. Certain it is, that sectional prejudice has operated to such an extent in former legislatures, as to stay the tide of improvement---nay, to divert it from its course---and keep it so for years. The men who lent themselves to this proceeding, have a great sin to answer for. They have done a deep injury to their State---many of them, no doubt, without being aware of it---but the evil is not the less.

Men of sound common sense---of integrity---of sufficient discrimination to know that fine, flowery speeches, and plausible exteriors, are not the only attributes of patriotism---who possesses a good practical knowledge of the every day affairs of life, together with an education, plain but fair, which can detect the designs of demagogues, and blow to pieces the webs of sophistry---are the men to make legislators.

Give us such men as these, and we will warrant that they are advocates for Internal Improvement---that they go with the age, and are not behind it---that they will spin no long-winded harangues and while away the time of the Assembly, preaching economy---of the great expenditures of the State---of its empty coffers---while all the time they are pocketing their *five* dollars a day, and remain in Milledgeville *five* times as long as it is necessary---for no other purpose, we presume, than to continue the agrea-

ble task of pocketing the aforesaid *five* dollars a day---and exhibiting their talent for speech-making.

We have made these remarks, because we see that many counties of the interior are about to make their nominations of candidates, and we hope they will have some effect. The policy of Georgia, above all others at this day, is to encourage Internal Improvements----sensibly and usefully conducted. Let the people of this State do their duty, and Georgia will assuredly become the highway for the commerce of the Mighty West. Let not party spirit interfere with this vital question; for we hope that both parties will, as in duty bound, choose men pledged to Internal Improvement.—*Georgian.*

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COMMISSIONER'S OFFICE, WESTERN AND ATLANTIC RAILROAD.

Cassville, April 30th, 1839.

SIR---That object of the fourth section of an Act, passed 23d December, 1837, requiring the President of the Board of Commissioners of the "Western and Atlantic Railroad," to make quarterly returns to the Governor of this State, may be effected, I herewith, in the absence of the President, and by direction of the Board, transmit to your Excellency, a statement of the work done on that road, and of disbursements made on account of the same, for the first quarter of the current year, together with the necessary vouchers.

| | | | |
|---|---|---|---|
| Aggregate of | Grading, | 1,184,704 | Cubic yards. |
| " | Masonry, | 11,285 | Perches. |
| " | Bridge Timber, | 480,588 | Feet. |
| " | Framing, | 10,617 | " |
| " | Iron, | 6,036 | lbs. |
| " | Bolts, | 373 | " |
| " | Zinc, | 480 | " |
| " | Com. road bridge timber, | 1,052 | feet. |

For which the sums payable monthly, agreeably to contracts, amount to $266,934 00 of which the sum actually paid is, $264,098 15

| | | |
|---|---|---|
| The sums retained for final settlement, on fulfilment of contracts, | 53,173 14 | do. do. 11,616 72 |
| Total amount chargeable on account of construction, | 320,107 14 | |
| Paid for right of way, | | 2,800 50 |
| Paid through Chief Engineer to Engineer Department, and for other objects, | | 19,952 86 |
| Paid incidental expenses, | | 628 50 |
| Total amount disbursed, | | 299,096 75 |
| Balance due on amount payable, | | 2,835 85 |
| Balance due on amount retained for final estimates, | | 41,556 42 |
| Aggregate cost on 1st quarters operations, | | $343,489 00 |

All of which will appear by reference to accompanying documents, marked A, B, C, D, E.

I have the satifaction to add that with the exception of an affray which occurred among some laborers near the 5th section of the first division, and which resulted in the death of two individuals, harmony has prevailed upon the line during this quarter, and that the work is progressing with a rapidity corresponding to the magnitude of our disbursements.

Very respectfully your Excellency's,

THOMAS HAMILTON, *Com. W. & A. R. Road.*

His Excellency, George R. Gilmer.

## AUGUSTA CITY COUNCIL.

The following resolutions were passed at the last meeting of the Augusta City Council:—

By Mr. Harper.

*Resolved,* That the City Council of Augusta will unite with that of Savannah in a memorial to the next General Assembly of Georgia, praying for the State's aid, by a loan of its bonds for the sum of $100,000 to each city, to be used, if deemed expedient, in effecting a continuous railroad communication between the two cities; the work to be commenced at Augusta.

By Mr. Harper.

*Resolved,* That the City Council will apply to the General Assembly of Georgia, at their next session, to make an adequate appropriation for deepening, under the superintendence of a competent Engineer, the shallow bars of the Savannah river, so as to admit of Steamboat Navigation in low river, and respectfully request the City Council of Savannah to unite with them in this application.

By Mr. Nelson.

*Resolved,* That the City Council of Augusta defer any further action on the application from the South Carolina Canal and Railroad Company, respecting the location of a depot in this city, until the report from the committee of five, appointed by the citizens, be received.—*Constitutionalist.*

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## EXPERIMENTS ON BLASTING.

Some weeks ago, a large party of gentlemen assembled in Craigleith Quarry, at two o'clock, to witness some experiments on blasting by means of galvanism, which were made at the request of the Directors of the Highland and Agricultural Society of Scotland, by Martin Roberts, Esq.

The apparatus consists of a small trough about a foot in length, and four inches square on the end, and a battery containg ten pairs of plates. Along the battery runs a bar upon which a tin disc slides freely. This disc, when drawn to the end of the bar, touches another disc, and thus completes the connexion between the opposite poles of the battery. To prevent accidents, the sliding disc is kept in the middle of the bar by means of a spring of colied wire; and it is impossible to put the battery in action, although sunk in the trough, without shifting the plate along the bar to the opposite end of the trough. The copper wires which convey the electric fluid to the gunpowder, are kept separate during their whole course by a sheath of cotton thread, which is wrapped closely round them in the same manner as in the strings of a guitar, or as in the wire which stiffens a lady's bonnet. At their termination these wires are bent outwards, and their extremities are connected by means of a fine steel wire half an inch long, so as to form a small triangle like the Greek capital delta. This triangular end is inserted into a small tin cartridge, and ignition of the powder contained in the cartridge, is produced by the deflagration of the steel wire which connects the ends of the two copper wires. So rapid is the progress of the electric fluid, that it is impossible to measure the interval of time which elapses between the action at the trough and the explosion of the cartridge. The cost of this apparatus is only about fifteen shillings, and the price of the materials required for the solution is such, that a shilling will cover the expense of keeping the trough in a working state for months. The copper wire, which, if properly shielded, may last for years, costs about one farthing for each yard.

One great advantage of this new system of blasting is, the great facility which this mode gives for blasting under water. This is one of the most

inconvenient, expensive, and uncertain of all engineering operations. It involves much trouble and expense in laying hoses for the train or fuze, which are destroyed every time, and after all there are, perhaps, three failures out of ten trials. All this is avoided by Mr. Roberts' system, which is as efficient under water as above it, and involves not one farthing of loss under water more than on land.

There is absolutely no vent hole in the mode of tamping pursued by Mr. Roberts, which mode cannot be applied to the present system of blasting. This is an important gain, the vent hole being a decided loss of power, which is well known to gunners, and to counteract which, the Turks are in the habit of covering the touch-hole of their guns with a bag of sand the moment the priming is fired.

It follows that a great economy in the article of gunpowder must result. This is a far more important item in the expense of quarrying and rock excavation, than is generally imagined by those who are unacquainted with such works. In the excavation for the Philadelphia Water Works, for example, nearly 3,000*l.* were expended in gunpowder, and at the rock cutting for the new approach to Edinburgh, by the Calton Hill, 1,000*l.* was spent in this item alone. In granite quarries, the powder for a single shot often costs 3*l.*

In the experiment made under water, 5 lbs. of powder were put into a bladder, and sunk to the depth of ten feet under the surface of the water, in a deserted quarry west of Craigleith. The string was drawn, and the effect was instantaneous; a dull red globe of light, caused by the explosion of the powder under water, was observed, and immediately there followed a considerable shock, which was sensibly felt on the margin of the pool, at the distance of about 100 yards from the explosion; a mass of water, about ten feet in diameter and two feet in height, shaped like a flat dome, rose above the surface of the pool, and immediately after it disappeared, the mud and burned powder boiled up from below like a cauldron.—*Edinburgh Weekly Journal.*

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## ADAMS'S PATENT RAILWAY CARRIAGE SPRINGS.

The application of a newly invented spring to railway carriages, has satisfied many persons competent to decide on its merits that it will be the means of several highly desirable changes in the construction and fitting up of almost every kind of vehicle used on railways.

The spring alluded to is the invention of Mr. Wm. Adams, the eminent coachmaker, of Drury lane, and author of the very clever, entertaining, and instructive volume, lately published under the title of "English Pleasure Carriages." It was invented by Mr. Adams about a year ago, and has already been very successfully applied by him to private common road carriages. It is called, from its form, the Bow Spring. The back is made of a single bar of well tempered steel, which is attached at the middle, lengthwise, to the axletree. The *string*, or what may be so considered, consists of two equal lengths of single bar steel or prepared hempen cord, the inner ends of which are linked to the body or frame of the carriage. The contrivance may, in fact, be said to consist of three springs—the back, or bow-shaped spring, and the two straight springs which form the chord of the arc, but all three acting simultaneously and in harmony with one another. As the two straight springs play as well forwards as backwards, they serve to prevent any longitudinal concussion, whether the engine be drawing or propelling, or whether the carriages continue moving in one direction, or are brought suddenly to a stand still. The only direction in which they do not play (independently of the carriage,) is from side to side; and therein consists a great excellence, since they thereby help to give lateral firm-

ness to the whole locomotive frame, and to keep it steadily in the line of motion—a line which it is needless to say cannot be *too straight.* The strength of all the three springs may be made proportionate to the weight of the carriage to which they are applied, consideration being paid to the kind of work to be done, and the quality of the road to travel; and as their greatest strength may be always tested beforehand, and no springs need be used that have not been tested to be capable of bearing a much greater strain than any which they are likely to be subjected to when in actual use, they may be said, in point of safety, to leave nothing to desire.

All these matters having been proved in respect to private common road carriages of different kinds, and Mr. Adams having satisfactorily shown that "English *Pleasure* Carriages" give a great deal more *pleasure* with a bow not always bent, but relaxed as circumstances may require, it was determined that an experiment should be made to ascertain whether the *Bow Spring* might not be, with equal advantage, applied to railway carriages. A sett of Mr. Adams's springs was accordingly fitted to one of the Post-office carriages on the London and Birmingham railway, and on the 17th of April last, a carriage provided with the bow springs started in a train from the station at Euston Grove.

The carriage in question had been at the station for several days before the 17th, and was inspected by many persons, several of whom—those, especially, connected with the railway—expressed an opinion that the springs were ill adapted to railway locomotion, and that the experiment about to be tried would fail—in more ways, too, than one.

It was said that the springs were too light.

That they would allow of a great deal too much motion:

That as there were no side guides to keep the axles true, the carriage would run off the rails:

And that they were not strong enough, and would be broken long before the train reached Birmingham.

The result of this difference of speculative opinion was, a great anxiety to see how the actual railway experiment came off (as the sporting phrase is.) Among those who took seats inside the carriage were the inventor of the spring, and several gentlemen well competent to appreciate the merits of the invention. On the outside were an officer of the Railway Company, and one or two post-office guards.

From the moment the train started, the superior ease and comfort of the carriage was felt, and severally acknowledged; but the apprehensions of want of strength in the springs—that the carriage would run off the rails—that they would break, and so forth, still remained, in hardly diminished force, in the minds of several individuals of the party.

At Watford, a pan was filled with water, and placed as nearly as possible in the middle of the carriage, on the floor. As the train attained its full speed, the water in the pan became agitated; at first the motion was irregular, but it soon became circular, and the ultimate effect of the centrifugal action was to throw the water over the pan. By the time the carriage had reached half way between Watford and Tring, nearly half the water had been thrown over the edge of the pan, but no more was thrown over during the remainder of the journey to Tring. At Tring, the train stopt to set down and take up passengers; and here Mr. Adams and his friends were congratulated by the Company's conductor and the two post-office guards on the success of the experiment, so far—the guards observing that it was by far the easiest carriage they had ever rode upon. They also gave it as their opinion, that the springs were of sufficient strength, and well adapted to keep the carriage upon the rails.

From Tring, the gentlemen who had witnessed the preceding experi-

ment, returned to town in a first rate speed carriage, placed at the same relative point in the train as was the carriage in which they travelled to Tring. In the middle of the carriage to which they had thus transferred themselves, and on the floor, they placed the pan before made use of, with the water which remained in it. As the train obtained its full speed, the water became agitated; at first it flew upwards in jerks; but it soon assumed a vibrating motion from side to side, and was forcibly thrown out on each side—ultimately, in quick succession—thus showing the great superiority of the apparently slight and elastic "Bow Springs" over the heavy, clumsy, lapped, and all but rigid, springs in common use.

The equability of the motion of the bow springs was such, that Mr. Adams, while the train was returning at the top of its speed, made a pencil drawing of the invention for a gentleman in the carriage, which it would have been impossible for him to have done in the carriage in which he returned to London.

One of the passengers by the outward train was Lord Macdonald, who had seated himself in his own well hung carriage, placed on a truck with the common springs. At some distance beyond Tring, his lordship accepted an invitation to proceed in the carriage with the bow springs, and travelled in it the remainder of the journey, at the end of which he made some very pointed observations on the superior ease and comfort of the carriage compared even with his own.

The carriage was taken onwards from Birmingham to Liverpool, was returned to Birmingham, and was tried by several of the directors of the London and Birmingham line, who are well qualified to judge of its merits, and by whom it is highly spoken of.

The application of the "bow springs" to every description of railway carriages will be attended with the following very prominent advantages:—

1. A great diminution of friction.

2. Diminution also of weight—because the elasticity of the springs, and the equable motion they produce, will admit of considerable reduction in the weight of almost any part of railway vehicles, and also in the fitting up of the locomotive engines.

3. Security of position on the rails. It has hitherto been deemed necessary to keep the axles in their positions by means of side guides, which, however, prevent them from accommodating themselves to any of the unavoidable inequalities of the railway.

4. Adaptation to all changes of circumstances. It has been found, by exact measurements, that the axles of many railway carriages are not placed accurately parallel, and cannot run true on the same line, the consequences of which are increased friction—increased wear and tear of the rails, the wheels, and the carriages, great additional weight in every part of the carriages to enable them to withstand the violent oscillations and concussions which even a small deviation (at high velocities) from true parallelism in the axles must occasion, while the power given by the bow springs to each wheel to accommodate itself to every ordinary inequality and impediment, is a remedy for all, or nearly all, of the evils to which reference has been made.

Looking at the invention as a whole, it is important to observe that it is one which in no respect depends upon fashion or opinion. It is of so simple and practical a character, that a very brief experience must suffice to settle, beyond all dispute and forever, the question of its utility; and should the result be as favorable to the superiority of the bow spring as we confidently anticipate, then will railway travelling become nearly all that we can every hope to see realized in point of luxurious ease and equality of motion.

## RAILROAD STATISTICS.

The following communication, in relation to the cost of motive power on railroads, is worthy of, and sure to receive, particular attention.

For the American Railroad Journal and Mechanics' Magazine.

Gentlemen:—By the politeness of the former superintendant of the Columbia and Philadelphia railway, I have been able to collect some facts relative to the cost of motive power on that railroad, which may not be uninteresting to your readers. The gentleman who furnished them is perhaps the only one in this country that has made the experiment, and is able to show so completely the expenses of the moving power, in every detail; yet on all roads, some kind of accounts are kept which will enable those interested to make a comparison. For this purpose, it is handed to you for publication. It is evident that railroads are not paying as well in this country as in England, and on the Continent; for which, I believe there are two reasons. The one is, that more passengers are taken over the roads in the old world, where the population is more dense; and the other is, our engines are heavier, our roads lighter, aad consequently the *repairs* to engines and roads swallow up the profits. If the machines put on our roads were built with an eye to save repairs to the road, and themselves, the profits would be much greater; but the contrary is the case. No regard is paid to the distribution of weight, if heavy loads are to be drawn, or ascents to be overcome—and the consequence is, the engine and road both soon require repairs; of course, the road pays no profit, and the inquiry is often made, why it is so. The answer usually given is, that the business is dull; which is often an erroneous answer. An engine should be able to run 90 miles per day, and be kept in order for six months; and it will, if properly attended to. The engineman should know as much as the superintendant about an engine. The practice of putting a fireman to run an engine as soon as he knows how to open the throttle, costs railroad companies thousands of dollars. It takes more judgment to run a locomotive than to drive a four-horse stage; yet, how often do we see persons entrusted with one of these valuable, and costly machines, that we would not deem sufficiently careful to take care of a horse. Lessons of experience, gained in this way, do not seem to have their proper weight; *or* the persons at the head of railroad companies, do not receive correct reports. No matter how well an engine may be constructed, it will be soon run down by an inexperienced and careless man, when a person who understands his business would have run the same machine for years. When we find such differences in the cost of motive power, as are exhibited in the annexed statement, we are led to believe that there is mismanagement somewhere; and naturally ask where it is? For my own part, I cannot undertake to say precisely, but can tell where I *believe* it lays; and will do so, in a future number. The statement of the cost of motive power on the different roads, is taken from the memoranda of the Chevalier de Gerstner;

and the other statement in relation to the Columbia and Philadelphia road, was prepared by Mr. Brandt, of Lancaster, Pennsylvania.

In 1838 the cost of motive power, for repairs, oil, fuel, attendance, &c., was per mile run on the

| | |
|---|---|
| Boston and Lowell Railroad, | 94 cents. |
| Boston and Worcester Railroad, | 79 " |
| Baltimore and Ohio Railroad, | 1 60 " |
| Richmond and Fredericksburg Railroad, | 80 " |
| Philadelphia and Columbia Railroad, | 55 " |

The length, and the manner in which each of these roads is built, and the kind of engines used on them, are all before the world, and I presume the readers of the Journal are familiar with their history; it is therefore unnecessary to make any remarks with regard to them. It is also well known that the Philadelphia and Columbia Railway is owned by the State of Pennsylvania, and the motive power is supplied by the State, while the cars are owned by individuals, or companies. In making a statement of what profit the road would have given to the State, if it had owned the cars, we will assume an indebtedness for them in addition to the cost of road and motive power, when we shall find that it paid a profit upon the whole outlay of *nearly* 12½ per cent.

| | |
|---|---|
| Original cost of the road, | $3,333,236 |
| Fifty locomotive engines cost, | 336,000 |
| Various appurtinances, | 330,764 |
| Cost of passenger depots, supposed, | 200,000 |
| Pay of agents and officers, | 55,625 |
| Three hundred and sixty-three cars at $275 each, | 99,825 |
| Twenty passenger cars at $2000, | 40,000 |
| Wear and tear, | 27,964 |
| Contingencies, | 20,000 |
| | 4,443,414 |

In the year 1838 there was carried over the road 87,180 tons

| | |
|---|---|
| 82 miles at $7 1-2 per ton, | 653,850 00 |
| 75,612 passengers $3 1-4, | 245,739 00 |
| | $899,589 00 |

| | | |
|---|---|---|
| The expenses were for carrying 87,180 tons at $2¼, | 217,950, | |
| " " " " 75,612 passengers at 1 60, | 120,979 80— | 338,929 80 |
| | Net receipts, | $550,659 20 |

Which is 12 39-100 per cent on the preceding statement of cost. I consider it as very remarkable that the State can manage a road with more profit than a company, yet so it is, and as some may doubt the correctness of the assertion, I give the different expenses in detail, which are as follows.

A statement of the cost of working the Philadelphia and Columbia Railroad from October 31, 1837, to October 31, 1838.

| | | | |
|---|---|---|---|
| Cost per trip the distance of 82 miles, | $44 03 c. | 5 m. | |
| The fuel costs per trip of 82 miles, | 14 04 | 1 | |
| Cost per ton the distance of 82 miles, | 1 55 | 3 | |
| Cost per ton per mile 7,562,040 tons, | 1 | 8 | |
| Fuel cost per ton 82 miles, | 50 | | 79-100 |
| Cost of repairs per ton 82 miles, | 27 | 4 | |
| Cost of repairs per ton per mile, | 3 | 3 | |
| Cost per mile travelled for repairs of engines, | 9 | 7 | |
| Cost per mile travelled 260,400, including all repairs, attendance, &c., | 54 | | 99-100 |
| Cost of maintanance of planes per ton 82 miles, | 18 | 3 | |
| Engineer's and firemen's pay per ton 82 miles, | 18 | 8 | |
| Cost of maintenance of planes per mile per ton, | 2 | 2 | |
| Engineer's and firemen's pay per ton per mile, | 2 | 3 | |
| Cost for fuel per mile travelled, | 13 | | 86-100 |
| No. of tons per trip way and through 28 1-5 useful load, | | | |
| No. of cars per trip 14 2-7 | | | |
| Cost of oil per ton per trip 82 miles, | 7 | 1 | |
| Cost of oil per ton per mile, | | 8 | |
| Cost of oil per mile travelled, | 2 | 5 | 2-10 |
| No. of tons through and way trains, useful load 42 1-7 | | | |

Total number of tons hauled, allowing 15 passengers to a ton, and 87,180 tons of merchandise, was 92,204 tons 82 miles, as copied from the book of performances kept in that year.

A statement of the work done on the Philadelphia and Columbia Railway by 13 engines, manufactured by M. W. Baldwin, and the cost; said engines being taken in order as they come on the road, being the 13 last furnished by him to the State, from the time they commenced running till 31st October, 1838.

| 1837. When commenced. | Class. | No. of miles travelled. | No. of cars haul'd | No. of ts. dis. 77 ms. 3 ts pr car. | No of ts. dis. 1 m. over ascent of 45 ft pr mile. | No. of trips | No of ts. per trip thro' | Cost of repairs to engines. | Cost pr. m. haul'd | Cost pr ton pr m. | Cost pr ton dis. 77 miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Westchester Feb. 19.* | 3d | 30.636 | 1.973 | 5.919 | 455.763 | 268 | 22.08 | 1,715·97 | 5c 6m | .76 | c 28.97 |
| Virginia, Feb. 19.† | " | 36.421 | 3.729 | 11.187 | 861.399 | 473 | 23.65 | 1.658.48 | 4.55 | 1.92 | 14.82 |
| Paoli, Feb. 19.‡ | " | 36.036 | 3.426 | 10.278 | 792.099 | 468 | 21.98 | 1.148.45 | 3.16 | 1.44 | 11.14 |
| Connestoga, Feb. 22.§ | 1st | 5.929 | 1.549 | 4.647 | 357.819 | 77 | 60.35 | 131.62 | 2.21 | .36 | 2.83 |
| Ed. F. Gay, March 24. | " | 25.872 | 7.265 | 21.795 | 1.678.215 | 336 | 64.86 | 1.457.78 | 5.63 | .87 | 6.68 |
| Parksburg, April 2. | " | 24.178 | 6.361 | 19.083 | 1.469.391 | 314 | 60.77 | 1.591.29 | 6.58 | 1.08 | 8.33 |
| Octarara, April 7. | " | 13.552 | 3.628 | 10.884 | 838.068 | 176 | 61.84 | 771.90 | 5.69 | .91 | 7.09 |
| Pequa, April 24. | " | 14,168 | 3.664 | 10.992 | 846.384 | 184 | 59.73 | 1.221.69 | 8.61 | 1.44 | 11.11 |
| Downington, Apr. 16. | " | 26.257 | 7.074 | 21.222 | 1.634.094 | 341 | 62.23 | 1.475.23 | 5.64 | .9 | 6.95 |
| Indiana, May 1. | " | 26.026 | 6.975 | 20.995 | 1.611.225 | 338 | 61.90 | 562.80 | 2.16 | .34 | 2.68 |
| Mississippi, May 9. | " | 15.323 | 3.915 | 11.745 | 904.365 | 199 | 59.02 | 1.384.01 | 9.04 | 1.41 | 11.07 |
| Montgomery, May 15. | " | 21.406 | 5.261 | 15.783 | 1.215.291 | 278 | 54.99 | 830.64 | 3.88 | .68 | 5.32 |
| Wisconsin, May 28.‖ | " | 8.624 | 2.160 | 6.400 | 480.960 | 112 | 51.85 | 82.22 | .95 | .17 | 1.26 |
| | | 274.428 | 56.980 | 170940 | 13.162.380 | 3.564 | | 14.031.59 | 5.18 avera. | 1c. avera. | 9. avera. |

* This engine run 10,000 miles, below the Schuylkill plane, of which the number of cars were not kept.

† Run the passenger train.

‡ Do. do. do.

§ This engine was on the Portage road six months of the time.

‖ This engine was used on a ferry boat, to propel it, at Clark's ferry all the season.

N. B. All those engines whose repairs exceed 1000 dollars, met [during the period of 17 months, at different times,] with accidents, such as running off the track, and breaking their axles, springs, or frames, so that the mere wear alone, or repairs occasioned by running, would have been less. The Westchester is not allowed any cars or expenses for 10,000 miles which she run from Broad-street to the Schuylkill plane—all her repairs being charged to the number of cars she hauled over the road, which, if allowed, would diminish her expenses considerably.

The Paoli and Virginia, run with passenger trains took less cars, but run more trips—the first running 473 out of 530 working days, the second 468 out of the same number of days. One loosing 57 days, the other 62. The other engines did not fill up the time so, because freight was not to be had at all times. Should you publish this communication, you may hear from me again, and I hope from others, giving details in relation to cost of motive power on other roads. A CONSTANT READER.

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LETTER TO THE SECRETARY OF THE TREASURY, ON THE HISTORY AND CAUSES OF STEAMBOAT EXPLOSIONS, AND THE MEANS OF PREVENTION. BY W. C. REDFIELD.

(Continued from page 30.)

13. *Explosion of a steam-boiler upon the Tyne.*—On Sunday morning, the 2d instant, the Vivid steamboat, belonging to four brothers named Greener, of Shield, was engaged to tow some ships out to sea, and had got her steam up for that purpose, when the owners [who worked the boat] found that she was not in a fit state to do so; they accordingly brought her up, and, while two of the brothers were employed in raking out the fires, the boiler exploded with great violence, and dreadfully scalded two men who were below. They were immediately conveyed home, where they lingered a few hours and then died. The deceased were men of excellent character, and much respected: one was a single man, but the other has left a wife and family to regret his loss. This accident appears to be the more singular, as the boiler had been undergoing some repairs, and was only furnished on Satuaday. An inquest will be held by S. Reed, Esq., coroner, this day, [Tuesday,] at 3 o'clock. Several of the steamboats running between Newcastle and Shields are now in the habit of so much overlading their boilers that, unless some check is put to the practice, we shall not be surprised at some dreadful accident occurring. Some person, who is competent to the duty, should look to this without delay. We are glad to hear that the Government have it in contemplation to appoint an officer for the express purpose of examining steam vessels, and of affording protection to the public.—*Tyne Mercury*, [1838.]

14. *Accident to the boiler of the Sirius**.—London, October 3, 1838. The

* This steamer had recently visited New-York.

Sirius, [steamer,] Ellis, reported yesterday as having sailed from her moorings off East-lane stairs for St. Petersburgh, did not get farther than the Pool, when an accident happened to one of her boilers. The damage can be repaired in two or three days, when she will proceed on her voyage.

15. *Steamer Northern Yacht foundered.*—It has been ascertained that the steamboat Northern Yacht is lost. She was seen to sink, and all on board perished---twenty-three in number.—*English paper*, [*October* 1838.]

16. *Steam-boiler explosion.*---Yesterday morning just before 6 o'clock, the boiler of the steam-engine which moves the machinery in the wadding manufactory of Messrs. Richards and Taylor, of James-street, a short distance south of Kennington Common, blew up with a loud noise, throwing the whole length of the engine house into the street, and with such force as to knock down several yards of a wall on the opposite side of the way, a distance of fifty feet. Had the explosion occurred but five minutes later, when a number of persons would have collected in the street prior to their going in to their work, the consequences might have been fatal to many. The engine is of 30 horse power; but the boiler is only capable of working to 20 horse power. No cause can be assigned for the accident. Fortunately no one was injured.---*English paper*, [*August or September*, 1838.]

17. *Sinking of the Hope steamer.*---A towing steamer, named the Hope, of Shields, on entering the harbor, ran foul of a dredging vessel which is used for cleaning the harbor; the steamer became very leaky, and sunk near the head of the pier. She has since become a total wreck: crew and part of the materials saved.---*Sunderland*, [*Eng.*,] *October* 13, 1838.

18. *Disastrous and fatal accident.*---On the morning of Saturday se'nnight, the neighborhood of Upper Easton, near Bristol, was thrown into great alarm by the sudden explosion of a large steam engine boiler on the premises of Messrs. Bayly & Co., lead smelters. The effect was most terrific, and showed the immense power of steam. The boiler, which was nearly twelve feet high, and thirty-five feet in circumference, and which weighed between three and four tons, was literally carried through the roof of the building, over an adjoining workshop, into a field eighty yards distant, tearing down a stack of chimneys. The shower of rafters, bricks, tiles, and stones, which accompanied the explosion, was truly awful. The roads and fields close to the works were covered with the fallen fragments; and a broad-wheeled wagon, loaded with small coal [the whole weighing four tons] was thrown several yards, and upset; the near-hind wheel being struck off the axle-tree. We are sorry to say that six persons, including the engineer, [who was supposed to have been feeding the fire at the time,] were dreadfully scalded and taken to the infimary. Three of the sufferers have since died. From the inquest, held before J. Langley, Esq. coroner, it was found that the engineer, who has unfortunately perished, was the cause of the accident. He ignorantly overloaded the safety valve, from some misconceived notion of trying the strength of the boiler after it had been newly repaired.---*January* 1836.

19. *Burning of the Royal Tar.*---The British steam vessel Royal Tar, from St. Johns, N. B. bound to Portland, with one hundred passengers, in October, 1836, took fire, owing to some defect about the boiler, and was destroyed. Thirty persons lost their lives by this disaster.

20. *Disastrous shipwreck of the Rothsay Castle steamer.*—The steamer Rothsay Castle, from Liverpool for Beaumaris, was lost in the month of August, 1831, and a great number of persons perished.

A volume of 322 pages, relating to this disaster, is now before me.* To

* Narrative of the Wreck of the Rothsay Castle steam packet. By Joseph Adshead, London. Hamilton, Adams & Co. 1834.

a list of the persons on board, which it contains, the author appends the following statement:—"This list presents the number of 141 individuals who are *known* to have been on board the Rothsay Castle at the period of her wreck; and if the moderate calculation be admitted that nine only were lost, of whom nothing has been heard, it will realize the estimate I have hazarded at page 289, namely: that 150 persons were on board, of which number *one hundred and twenty-seven perished.*"

21. *Dreadful shipwreck of the Forfarshire steamer from Hull to Dundee. Thirty-five lives lost.*—One of the most dreadfully calamitous shipwrecks that has taken place on the coast of England—perhaps involving the greatest loss of life since the loss of the *Rothsay Castle* off the Isle of Anglesea—took place yesterday week, off the coast of Northumberland, when the steam vessel called the *Forfarshire*, on her voyage from Hull to Dundee, struck on the rocks of the Farn Islands, and no less than thirty-five of the passengers and crew perished. This steamer, which was a fine large vessel, of 400 tons burden, provided with two boilers, appears to have been lost owing to the bad state of her boilers; and although she was exposed to very rough weather, yet, as will be seen, her boilers must have been in a defective state when she quitted the Humber.

The Forfarshire sailed from Hull for Dundee on Wednesday afternoon, the 5th instant, at 20 minutes past six o'clock, along with the Pegasus and Innisfail, for Leith. On Thursday morning, about four o'clock, the boiler became leaky, but it was partially repaired; and the steamer proceeded on her voyage, till she arrived at the mouth of the Frith of Forth, about ten o'clock in the evening. It then blew a heavy gale from the northward. The boiler, it would appear, had now become useless, and the machinery stopped. The vessel was got about, in the hope to get her before the wind, but she soon became unmanageable. It rained heavily, accompanied by a violent gale, with a heavy sea, and the vessel drifted towards the Farn islands, on the outer one of which she struck about three o'clock on Friday morning. The captain (John Humble, late master of the Neptune, of Newcastle,) did not, from the state of the weather, know where he was, nor was danger apprehended until breakers were discovered close under the lee of the vessel. As soon as the breakers were discovered, the steward went into the cabin to warn the passengers (who were in bed,) of the danger. They rushed to the deck, which the most of them must have reached before the vessel struck; but as the steamer, almost instantly after striking, parted into two pieces, the whole of the cabin passengers, twenty-five in number, [with one exception, who, with eight of the crew, got on board one of the boats,] are understood to have met with a watery grave. Among the cabin passengers were several ladies. The crew consisted of 22, 10 of whom, and the captain, are drowned. Five steerage pessengers and four of the crew were taken off the fore part of the wreck, in the course of the morning, by a boat belonging to the light-house on the island. Thus it would appear that thirty-five persons have lost their lives. Only one cabin passenger, Mr. Ruthven Ritchie, Hill of Ruthven, Perthshire, was saved. —*Leeds Mercury, September* 15, 1838.

22. *Dreadful boiler explosion.*—In Woolhouse's edition of Tredgold, there is mentioned the explosion of a large English boiler of the old spherical form, 20 feet in diameter, in which the thickness of the plates was from a quarter to half an inch; the load upon the safety valve seven pounds per circular inch. Many lives were lost by this explosion; and the boiler was thrown to a distance of 150 feet, to a place 30 feet above the level of its former seat.—*Tredgold*, p. 251.

23. *Blowing up of the Earl Grey steamer.*—On Friday evening, a few

minutes before six o'clock, a dreadful accident took place, occasioned by the bursting of the boiler of the Earl Grey steamer, while she was lying at the steamboat quay, on her way from Dunoon to Glasgow. The Earl Grey had been moored at the quay about 15 minutes, and was just on the point of starting, [the bell having been rung,] when an explosion happened of so dreadful a nature, that the boiler was rent completely round, the roof forced up into a perpendicular position, the upper flues driven into the cabin, and the lower part of the boiler and under flues removed from their situation; blowing the deck completely off from the funnel, to within eight or nine feet of the stern. The unfortunate persons who were standing on that part of the deck were blown into the air; two of these fell upon the quay, both of whom died immediately after; the rest fell into the sea. The water from the boiler was thrown nearly to the west end of the steamboat quay, over the shed, on board two vessels, the Jean and the Rebecca; the rope which fastened the steamer's stern to the quay was blown on the top of the shed, also camp-stools, large pieces of wood, &c. A part of the boiler, six or eight feet square, was driven, by the force of the steam, a distance of 100 feet and upwards. A great number of persons standing on the quay were much injured by the scalding water, and by pieces of coal, wood, &c., falling on them.

By this melancholy event, six persons have lost their lives, fourteen been severely injured, and twelve slightly, [thirty-two in all;] but it is impossible at present, to state the precise number of the sufferers by this dreadful occurrence, as it is believed that some of those thrown into the water have not been found. The steward says that before the accident, he counted 27 persons on the quarter deck, and considers that there were about 40 persons on board at the time of the explosion.

The steward of the Earl Grey, while standing on the paddle-box was knocked overboard by a large piece of coal, but got out little injured. Excepting the steward and one seaman, who was killed, no other person connected with the vessel was hurt. A young lady, Miss Stevenson, had gone on board the vessel, accompanied by her sister and a young gentleman, a few minutes before the accident took place. The young man had gone forward to the bow, leaving the two young ladies standing abaft the funnel at the moment the explosion occurred. When the steam and smoke had cleared away, he discerned one of the Misses Stevensons, in the water at a considerable distance from the vessel, and, although an indifferent swimmer, he plunged overboard and saved her. The body of the other sister was got out of the water an hour and a half after the accident, by the boats which were employed in trauling, but no other body has yet been found.

Mr. Mathew King, of Port Glasgow, who was with Mrs. King, blown overboard, saved himself by clinging to a block attached to a rope which hung over the vessel's side. While in this situation, he saw Mrs. King floating; he immediately got hold of her, and, while supporting himself with one hand, and holding his wife with the other, some person seized hold of the rope Mr. King was clinging to, and nearly pulled it from his hand. Mr. King with great difficulty, got him to desist until a boat came to their assistance, and rescued them just in time, as Mr. King had become completely exhausted. Mr. Hugh Watson, who is mentioned among those killed, was on the deck at the time of the explosion, the force of which blew him and Angus Wilkie, who was loosing the stern line at the moment, a great height into the air. They both fell on the quay, and the bruises they received from this, together with the effects of the steam and the scalding water, caused almost instant death in both cases.

Mr. Peter Somerville, of Glasgow, one of the passengers, who saved

himself by his singular activity and presence of mind, described to us, in the following manner, the circumstances connected with the blowing up of the vessel, as far as his own observations had extended. Mr. Somerville was surprised at perceiving the cabin to be full of steam, and, becoming apprehensive that something was wrong, he advanced to the farthest end, when a hissing noise which he heard convinced him that an explosion was about to take place, and he sprung suddenly out at one of the cabin windows, breaking the glass, a pane about 14 inches square. Instantaneously as this was done, the explosion occurred before his legs were quite out of the window, and his feet were scalded by the hot water, or steam rushing into the cabin. Fortunately Mr. Somerville succeeded in catching hold of an iron rod projecting from the stern, by which he hung until the stern boat had been lowered, when he was drawn up to the deck of the vessel. While thus hanging by the steamer's stern, Mr. Somerville looked down into the water, in which he thinks he observed about thirty persons, many of whom appeared to have been hurt by the explosion, and were streaming with blood. He saw six or seven couples clinging to each other as if resolved to be saved or lost together. On being hauled up the stern, Mr. Somerville found that the greater part of the deck had been torn up. On the only portion of which now remained, namely, a few feet of the stern, he observed an old gentleman evidently much hurt, and a lady of apparently about forty years of age, who was either dead or had swooned. All the other cabin passengers appeared to have been blown off the deck by the violence of the explosion.

The quay at which the vessel was lying at the time of the accident was in an incredibly short time crowded by persons of all descriptions.

The excitement was much increased by the wounded sufferers being borne along the streets to the infirmary, and various other places. The steamboat quay, about seven o'clock, presented a scene of horror happily never before witnessed here--mangled and bleeding bodies carried to the places where aid could be administered; the boats employed in trauling for the bodies rowing backwards and forwards, anxiously watched by the spectators whenever the men aboard hauled up the creepers, to which, in almost every case, were hanging pieces of clothes, shirts, handkerchiefs, &c. But the most fearful spectacle of all was the vessel herself--the roof of the ponderous boiler poised in mid-air, over which the funnel lay crushed and broken; the uptorn decks exposing the cabin, into which the upper flues of the boiler had forced their way; while hats and portions of male and female attire were strewed around, telling too truly of the fearful destruction that had taken place. It may be consoling to the friends of those who were injured to know that every thing which humanity and skill could devise was done to alleviate the agonies of the unhappy sufferers.—*Greenock Intelligencer*, *July*, 1835.

24. *Explosion on board the Victoria steamer.*—On the 14th of June 1838, a dreadful accident happened in the river, by the explosion of a boiler on board the Victoria, Hull steam-ship, by which nine unfortunate men lost their lives.—*Shipping Gazette.*

This explosion, and another which also occurred on the Thames a few months previous, on board the same vessel, by which several lives were lost have already been alluded to.

There are other cases of like character before me of earlier date which I omit to notice; but the above are sufficient to show that these accidents are not confined to American steamboats, but often occur with low pressure engines under the English practice.

The various hazards and casualties here enumerated serve not only to

show that the hazards which have hitherto attended the use of steam are not confined to our own country, but that the use of steam of only five or seven pounds pressure to the inch, with a dependence on nicely adjusted safety-valves and other apparatus, will not insure safety; and that the latter must be sought in the surplus strength of the boilers employed.

Of the foregoing cases of the shipwreck of English steamers, it may be remarked, that a large portion of those which were most disastrous, could probably have been avoided had their engines possessed equal efficiency with those which are used in the New York steamboats.

*Steamboat Legislation.*—The subject of legislative enactments for promoting the security of passengers in steamboats, has often been a matter of discussion since the latter were first introduced in our country. But, till recently, there has appeared an evident reluctance to legislate on subjects relating to the arts and occupations of particular professions; such interference being generally considered as ungenial to the character of our institutions, and contrary to sound policy. The objections to legislative interference were peculiarly strong in the case before us, owing to the infancy and importance of the art in question; the professional knowledge and experience which were required to regulate it with success; and the difficulty, not to say impracticability, of devising a system of legislation which should be adapted to all the diversified circumstances of this great country, and to the rapidly improving state of the art itself.

There is, however, but a small fraction of the people of the United States who are directly concerned in steam navigation, and the unhappy disasters which have attended it have presented to our contemplation dangers of a new and appalling character, and have occasioned ceaseless efforts for the accomplishment of such legislation as should, in reality or appearance, offer security to those persons, who, under the lively impression of danger, could discover little else than incompetency, treachery, or suicidal depravity, in those who conducted the operations of this new and powerful element of locomotion. A few in the profession itself, being impatient, perhaps, of the opposition offered to their views, or of the continued existence of evils and defects which to them appeared susceptible of a prescribed remedy, have joined in recommending the interference of the national legislature. It remains to be seen whether this interference is to be productive of more good than evil. That it has signally failed in preventing the recurrence of the calamities which have been deprecated, is too apparent in the explosion of two steamboats on the Mississippi, which were fresh from under the legal inspection, and which have been attended with a fearful destruction of life.* It is much to be apprehended, therefore, that these enactments can serve no better purpose than to relieve the owners and managers of steamboats, in a measure, from that weighty sense of responsibility to the public under which they have hitherto labored, irrespective of their private interest in the safe and prosperous conducting of their business.

But, aside from the more than questionable policy of some of the enactments of the statutes in question, there is one provision, adopted without notice, and, apparently without premeditation, which appears to be a reversal of the principles which have hitherto prevailed in our system of legislation and jurisprudence—a provision which appears as injurious and unjust in its implications of a most useful, worthy, and patriotic class of fellow-citizens, as is the misapprehension of fact and of character, on which it would

* Other deplorable accidents have since been added to the catalogue; and these renewed disasters may serve to show, first, that the remedy does not lie within the reach of the legislature; and second, that our western friends *must* relinquish their ultra system of high pressure, which has so long been cherished on their waters.

appear to have been founded. I shall be understood as alluding here to that provision of the late law of Congress which assumes the owners of steamboats to be guilty of misconduct and liable for all injuries or losses, in cases of injury or explosion by steam, unless they may be able to produce satisfactory evidence to the contrary—a task which, with the purest conduct and intentions on their part, might often be rendered impossible. It is sincerely desired that such a provision may not long be found in our statutes. The common law of the country is sufficiently relentless and severe in all cases of implied criminality, or even of negligence; and a resort to the enactment in question would seem justifiable only in relation to a class of persons who were universally and odiously criminal, instead of a class who, in every thing which constitutes private worth and good citizenship, are probably not inferior to most others in our country.

The owners and constructors of steam vessels have not been examined or consulted by the committees which have been charged with the preparation of the late law. Nor have those persons intruded their private opinions and views upon Congress, nor upon the public. Still less have they been disposed to place themselves in an attitude of defendants, on groundless and absurd allegations; or even to plead the great benefits which they have rendered, or the sacrifices which they have made, while engaged in advancing one of the most important interests of the public and of the civilized world. While the state of the country, its society, its business and enjoyments, have been so rapidly improved or changed by their operations as to excite the wonder not only of an admiring world, but even of ourselves, these persons have been content to labor, through good and evil report, as willing instruments in the rapid advancement of their country in its industry, knowledge and power. Well might they have anticipated any other notice from the supreme power of their country, rather than the apparently ungracious rebuke which seems to be implied in the above enactment.

The pecuniary sacrifices which have been made by the owners of steamboats, while thus advancing their country's best interests, have been great almost beyond example. It was estimated, some five years since, that the amounts which had then been lost by the owners of steamboats which have navigated the Hudson, this queen of rivers, was sufficient to have constructed a good railroad between the cities of New-York and Albany; and there is reason to believe that the losses have been at least proportionate in other sections of our country. Surely, it might have been expected that this interest, above all others, would have been deemed worthy of the countenance and protection of our National Legislature.

In a reply to the inquiries of the honorable Louis McLane, Secretary of the Treasury, dated December 23, 1831, (which appears as No. 3, in document No. 478 of the House of Representatives, 1st session of the 22d Congress,) I have cursorily noticed some of the points which are herein referred to. To this communication, and especially its concluding remarks, I beg leave now to refer.

Of the regulations for preventing collisions in navigation, those which are found in the laws of the State of New-York are, in my view, of far greater practical value than those which are found in the late act of Congress.

Among those persons who control the forms and modes of construction of steam-boilers and engines, there is found much variety of opinion and practice, which necessarily occasions different degrees of excellence or defectiveness. To unite, at once, these various views in the most perfectly approximate system of security and efficiency, by the operation of a blind

external power, is quite impracticable. It is only by extensive practice and patient observation that so desirable a result can be reasonably expected; and *time* is essential to its attainment. It is not unreasonable to expect that the period is rapidly approaching in which American steamboats will as far exceed those of other countries in safety from explosions, as they now do in practical efficiency, and in skilful adaptation to the purposes for which they are specifically designed.

*Prevention of explosions.*—In adopting rules of construction for boilers, it should be considered that iron is liable to be permanently affected by a force which is equal to only one-third of that which is necessary to produce immediate fracture. The point of maximum pressure, therefore, at which the steam-gauges should be adjusted, so as to blow off their mercury, should never exceed one-third of this subordinate force. In other words, the highest pressure of steam allowed under any circumstances, should not exceed *one-ninth* of the force, which may be fairly estimated as necessary to break or immediately injure the boiler, instead of being equal to only one-third or one-half of this force, as is recommended in Woodhouse's edition of Tredgold,* and, as I am informed, is usually practised in England.

Experiments, if deemed necessary, might be made upon boilers of the different forms of construction which are commonly brought into use; and these experiments, together with the estimated tenacity and stiffness of the metal employed, would serve for a basis in estimating the strength of any boilers, and the actual proof be thus avoided; for, a proof of high tension may, by its incipient effects, tend to produce, ultimately, the very disasters which it was intended to prevent.

Much has been said and written on the means of preventing explosions; and if the efficacy of the various preventives which have been proposed, had only been equal to the zeal and confidence with which they have been sometimes urged, we should have little occasion for pursuing the inquiry.

Of the experimental investigations which have been made, unconnected with working practice, none have a higher claim to consideration than those made at Philadelphia by a committee of the Franklin Institute; and the elaborate report of this committee must be considered as a document of high value and great practical utility. The report of the committee of the American Institute of this city, on the explosion of steam-boilers, is also a well reasoned production, indicating a thorough knowledge of the subject on the part of the committee; although I cannot accord to the implied conclusion, that the use of steam of more than seven pounds pressure to the inch must, necessarily, be considered as dangerous.†

Notwithstanding all which has been said and done on the subject of nicely-adjusted safety-valves and other apparatus, explosions still continue to occur; and so long as boilers continue to be subject to insidious and unknown defects, and the limit of their strength is found to be too nearly that of the working pressure, they cannot be expected to cease. The safety-valve and the mercurial gauge, as now used, are perfect instruments of their kind, and have all the adaptation that can reasonably be desired for showing the actual pressure, and for regulating its excess. In regard to the supply of water and its indications, good pumps of proper construction, with the ordinary gauge-cocks, glass tubes, and good attendance, constitute the safeguards most to be relied on. A thermometrical instrument might be added to the boiler, without detriment. Water-floats and their fixtures, I consider as ob-

* Tredgold, Part I., pp. 259, 240. London, 1838.
† See Journal of the American Institute, September, 1838. p. 646.

jectionable in marine boilers, and will not be found practically useful. In the present state of the art, new inventions of apparatus do not appear to be required, but only the judicious and proper use of such as we now possess, combined with boilers of *sufficient strength* to resist successfully all the ordinary defects, deteriorations and exposure, which may arise during their use, from inattention or otherwise.

If high-pressure engines must continue to be used, [of which I see not the utility or necessity,] the working pressure *should never exceed fifty pounds to the square inch;* and this may be easily effected by increasing the size and stroke of the working cylinders and piston.* The forms of the boilers should be cylindrical, and their diameters from 36 to 42 inches, supported by their centres as well as at their terminations. Flues, if of a size affording but one or two in each boiler, are always dangerous; they displace too much water, and also obstruct the proper cleaning. Flues, however, are not to be dispensed with; but their number should be increased and their size diminished. An upper tier of four flues, and a lower tier of two [the latter somewhat larger than the former,] are not too many for boilers of 42 inches diameter; or 44 to 48 inches, if low pressure. These smaller flues, if properly arranged, will greatly facilitate the cleaning, and displace but little water; but their length should not usually exceed ten or twelve feet, as they abstract the heat very rapidly, owing to their small size. They will be better if made perfectly smooth on their inner surface, from a single long sheet of iron, lighter than the shell; and are not often liable to leaks or accidents. The outer shell should never be less in thickness than a full quarter of an inch; and a thickness much exceeding this, it is well known, cannot be used with advantage.

In condensing engines which work expansively, called low pressure, when working with ordinary speed, the pressure of steam should usually range between one and one and a half atmospheres above the boiling point. But on emergencies, the pressure may be increased to two atmospheres. *The boilers should have a range of strength falling but little short of those used for high pressure.* They may be constructed of the common wagon-top form, provided that they are properly braced in their flat sides and arches, and have as many as four or six flue-arches for a boiler of eight or ten feet in width. The returning flues should be cylindrical, and of smaller diameter. The water sides, water bottoms, bridge walls, and all other flat surfaces, should, however, be brace-bolted at intervals of six inches; and the arches, shell, and all other portions, secured in a proportionate manner. If a *steam chimney* is used, even of the circular form, it should be brace-bolted at smaller intervals than any part of the flat surfaces which are covered by water.

Flat water-sides, ends, and bridge-walls, if rightly constructed, may be adopted with great safety and advantage for high-pressure boilers; but the brace-bolts, in these cases, should be at intervals of one to *five inches.* Good brace-bolts of iron, eleven-sixteenths of an inch in diameter, with light sockets, if the same are well and securely driven, will be sufficient.† These

* Since the above was written, I have seen the Report of Dr. Locke, on the disastrous explosion of the new high-pressure steamboat Moselle, at Cincinnati, in April, 1838; and I am happy to find that my general conclusions appear to be confirmed by the facts and observations which have been adduced by this distinguished friend of science: although there are some few of his positions that perhaps cannot receive the sanction of practical engineers. After an able examination of the facts in this case, Dr. Locke comes to the conclusion, that "with probably a sufficient supply of water to protect her flues, and the safety-valve over loaded, the Moselle burst her boilers by a pressure greater than the strength of her boiler iron, undiminished by heat, could sustain."—Report, &c. p. 52, Cincinnati, 1838.

† These brace-bolts are better to be screwed in, without sockets; and afterwards riveted, with or without an outside nut or screw-head.

water-sides and ends may be so worked on to the cylindrical portions of the boilers as to form one structure, in which a greater circulation may be provided for, and much of the ordinary sediment be prevented from becoming injurious to the boilers. The same principal of construction may also be adopted for low-pressure, as has been done in the boiler which has been used in the steamboat Oliver Ellsworth since 1833; but in such case the cylindrical portions or shells may have a diameter of 44 to 48 inches. The boiler heads should in all cases be of wrought or rolled iron, of extra thickness and securely braced. An addition, in the form of a truncated cone, may be affixed on the top of each cylindrical portion, in order to increase the steam room and to communicate with the steam pipe. The top or head of this appendage may be of cast iron, and calculated to receive the manhole plate and safety valve.

For low pressure boilers, the general form of the locomotive boilers, with numerous small flues, has been successfully adopted. For these boilers, if the requisite provisions for strength be carefully attended to, copper may sometimes be admissible; but in this case, the securities should greatly exceed those of an iron boiler of the same general construction.

In specifying these methods of construction, no new or untried plans have been suggested; but only those of known advantage and efficiency, such as have fallen within my own observation or practice.

In the use of muddy or salt water, the blow-off cock should be frequently and freely used. Condensation in a multiplicity of pipes, and the use of the distilled water thus obtained, on the plan which Mr. Hall has introducd in England, will probably be found attended with more advantages than inconvenience, particularly in sea voyages.

Boilers should at all times be kept free from sediment, and the riveted joints, especially those which are exposed to the fire, should be made subject to frequent and careful examinations, and the smallest appearance of leakage in these should receive immediate attention.

But, with all these precautions, it is *possible* that accidents of a serious character may sometimes happen to steamboats, as well as to ships, bridges, carriages, and other structures, in which much care and attention have been given to the best means of security.

Should the facts, however, which have fallen within my knowledge or observation, as set forth in this communication, or the conclusions derived therefrom, contribute, in any degree, to the correction of prevailing errors of theory or opinion, and cause a greater reliance to be placed upon the most available of all remedies, namely, *a proper increase in the strength of boilers, together with the abandonment of the higher degrees of pressure*, and thus secure a greater degree of safety to the travelling public, my object in thus responding to the call of Congress will be happily attained.

I am, sir, very respectfully, your obedient servant,

William C. Redfield.

Hon. Levi Woodbury,
*Secretary of the Treasury.*

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Arbroath and Forfar Railway.—One of the afternoon trains yesterday brought from Forfar, with a single engine, no less than *forty-three* wagons, loaded with timber and pavement, and two carriages, containing forty passengers. The gross weight of the goods' train amounted to two hundred and thirty-two tons. This is an achievement to which no parallel can be found in the annals of railways.—*Arbroath Herald, July* 5.

SEMI-ANNUAL REPORT OF THE DIRECTORS OF THE LA GRANGE AND MEMPHIS RAILROAD COMPANY, JULY, 1839.

Although it is not required by the charter to report until the close of the year, the peculiar situation of our affairs, seem to demand a brief semi-annual exhibit, as well for the satisfaction of the public generally, as the stockholders. Besides, the ensuing session of the General Assembly, will in all probability be the only one until the Road is finished; and if any legislative aid is sought, no time should be lost in apprising the stockholders of the state of our finances; and in suggesting such measures of relief, as may be judged practicable and expedient. An interchange of ideas, and mutual concessions, will alone enable us to approach the Legislature, with any probability of assistance. For apart from the diversity of opinion, attending the discussion of subjects of this nature, we are divided and distracted upon national policy, almost exclusively based upon that branch which relates to the state of the currency, and the measures which should be adopted to produce an uniform value in commercial or bank paper.—We think that the policy of creating State Banks is not now a subject open for discussion. A prudent exercise of the power, in constituting corporations, with banking privileges, is the only thing we shall examine—believing it the part of common sense to take the laws of commerce as we find them, and to accommodate ourselves to circumstances, over which we have no control.

It will be seen by statements herein made that the whole of the capital stock, to wit: $375,000, has been called. The individual stockholders are generally solvent and in ordinary times would be able to meet the demands. But with every reasonable exertion it has been found impossible to make collections. The truth is, the money is not in the country—and nothing but a bountiful crop and the increase of a sound bank paper currency can enable the Directors to enforce payments without producing a pressure which the stockholders, and thiscommunity generally, are ill able to bear. We have been reluctantly compelled to institute suits against all stockholders who have not paid fifty per cent., and unless a temporary loan of 50 or 60,000 dollars can be obtained shortly, we shall be obliged to extend the order to the remaining half. To avoid this oppression every effort has been made, and we now earnestly entreat every friend of the enteprise to lend a helping hand. Let each and all make a sacrifice of some cherished opinions to attain an acknowledged benefit. We can at all events agree to memoralize the Legislature for our rights—not the least important of which, is the assignment of our just proportion of banking capital. This West Tennessee is entitled to, and this we must have, or abandon our favorite schemes of Internal Improvement.

The unintelligible Banking and Internal Improvement and Common School law of last session, is pretty generally admitted to be next to a dead letter, and unavailable to any Railroad or Turnpike Company managed in good faith; and for all practical purposes, is nothing less than a downright mockery. For if it was intended that each and every stockholder, however small their subscription, should advance 15 per cent. before the State could be called upon for her quota, a default in the payment of $15, or an instalment on one poor share, might defeat the whole object of the law. Companies formed by general subscription, in ninety-nine cases out of a hundred, would contain some stockholders, who, from inability or neglect, would fail to meet their calls, aud thereby render the State's subscription inoperative. What the next Legislature will do with or about this indefinable statute is of but little consequence to our Company, unless it could be amended so as to be acceptable., and that is not probable.

Then what ought the citizens of West Tennessee to petition for? We say an Independent Bank, based upon legitimate banking principles; with a capital which shall be equal to one-third of the whole banking capital of the State—the Principal Bank to be locatcd at Memphis, with Branches established at as many points as the capital and business of the country will justify—or a Bank connected with our Railroad Company, on the plan of the Charleston and Cincinnatti Railroad and Banking Company. The latter we would prefer for several reasons. Indeed it is difficult to conceive the plan of a Bank less exceptionable, or better calculated, with judicious management, to secure public confidence. It would have an independent action of the Railroad Company, and in every respect be conducted as banking institutions generally are, except that the Railroad Company would guarantee the redemption of the issues of the Bank. The only advantage that the Railroad Company would derive, over and above the usual bank facilities, would be this: Every stockholder in the Road would be entitled to become a stockholder to the same extent in the Bank—That is, if he owned say 10 shares in the Road, he would have the refusal of 10 or 5 shares in the Bank—and to obtain shares in the Bank as many must be subscribed to the Road. And although the Railroad Company will be liable for the debts of the Bank, the Bank will not be responsible for the debts or mismanagement of the Railroad Company. We are aware that Railroad Banks, or Banks connected with works of Internal Improvement, have frequently been unsuccessful, but it should be borne in mind that in every instance of failure, the charters were defective. They were permitted to base their issues upon the credit of the stockholders, instead of a metalic capital and actual road formation combined, as we propose.

If we obtain the privilege we desire it will enable us to extend the Railroad from La Grange to the Mississippi line in the direction of Tuscumbia, in fulfilment of our original design of uniting with the Alabama, Georgia and South Carolina Rairoads.

Early in January last we memoralized the Legislature of Mississippi, to grant a charter for so much of the contempleted Railroad from Memphis to Charleston as might lie in that State, which was most unexpectedly refused. But we are informed and believe, that there will be no difficulty, at the next session, in arranging matters to our satisfaction. Should that State, however, persist in her unreasonable opposition to this great work, it should prompt the Legislature of Tennessee to proceed forthwith with the line, from La Grange to Chattanoga, the terminus of the Georgia Road. And we are of the opinion that whatever may be the course of Mississippi in relation to it, the practicability of a direct eastern route along our southern border should be tested without delay. For, the consummation of this magnificent design devolves upon Tennessee. South Carolina and Georgin have done their duty, and Tennessee must perform her part if she would avoid disgrace.

The La Grange and Memphis Railcoad and the branch from Moscow to Somerville, will be completed next year, or nearly so—certainly if the Legislature grants the expected facilities.

It will be seen by reference to the reports that the entire line will soon be ready for the superstructure, and that is being laid from Memphis to Germantown.

The state of the Treasury at present will appear by the following abstract of the Cashier's exhibit, embracing some of the most important items of information in relation to the receipts and disbursements of the Company, from its organization, June 15th, 1836, up to the present time:

*Abstract of the Cashiers Exhibit.—Receipts.*

| | |
|---|---|
| Received from individual stockholders, in cash, bonds, discounts, &c., | $88,183 12 |
| Seventy-five per cent. of State Stock in Bonds, | 93,750 00 |
| | $181,933 12 |

EXPENDITURES.

| | | |
|---|---|---|
| For Real Estate, (13 acres near La Grange,) | | $1,355 06 |
| Personal Property, Engineering Instruments, Tools, &c., | | 1,698 11 |
| Engineering Account, | | 26,540 71 |
| *Road Formation.* | | |
| Grubbing account, | $22,659 71 | |
| Grading account, | 91,173 71 | |
| Culverts and Drains, | 4,060 50 | |
| Bridge account, | 600 00 | |
| Timber account, | 12,636 60 | |
| Superstructure, | 171 79 | |
| | | 131,302 31 |
| Per centage retained on unfinished contracts not yet due, | | 15,833 00 |

(To be continued.)

THE DRY ROT.—It is stated as an important fact, and one worthy of general attention, that timber cut in summer resists the dry rot far better than winter felled timber; that the doctrine of sap being principally in the roots of trees in the winter is false, and should be discarded for the mischief it has already done; and that the truth should be established, which is, that in the winter, the sap is in the tubes of the heartwood of the whole tree, roots, and body, and branches, and is there protected from injury by the frost. In the summer the sap is in the tubes of the albernum, or outer covering of the heartwood, and when timber is felled at this season, should the dry rot attack it, the albernum only disappears, and the heartwood remains sound and dry. On the contrary if the timber is cut when the sap is in the tubes of the heartwood, [*i. e.* in the winter,] the disease continues its ravages till the whole is rendered useless.

THE IRON TRADE.—We learn from a very elaborate paper read by Mr. J. Johnson before the Liverpool Polytechnic society, that there are at this time in Scotland fifty furnaces in blast, five out, seven building, and tmenty-six contemplated. In South Wales, 122 furnaces in blast, seven out, thiy-one building, ninety-one contemplated. In 1740 the annual produce of the kingdom was 17,350 tons of cast iron. Mr. Johnson thinks it probable, from the above data, that in 1842, Scotland alone will produce upwards of 360,000 tons, and that within five years 1,000,000 tons, will be produced annually in South Wales. The market for metals has been greatly influenced by the money market; and though further pecided fall in the quotation to be noticed, the business is becoming exceedingly limited, and a general decline in prices is expected to take place, should there not be a better demand for the export trade.—*Midland Counties Herald.*

ERRATA.—Page 34, communication on "The true expression of the Power, etc. of Locomotive Engines," seventh line from top, for 'effected' read *affected.* Page 36, sixth line, for 'calculations,' read *calculation.* Same page, sixteenth line, for 'evaporation,' read *evaporated.* Same page, twentieth line, for 'or,' read *for.* Page 38, last column in the table, instead of '·01' it should have been ·01— Page 39, note b., second line, instead of 'fore 4' read *fore* ·4.

AMERICAN
# RAILROAD JOURNAL,
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LETTER ADDRESSED TO SAMUEL P. LYMAM ESQ., COMMISSIONER NEW YORK AND ERIE RAILROAD, 14TH DECEMBER, 1838, BY W. R. CASEY, CIVIL ENGINEER. –REVISED FOR THIS JOURNAL, AUGUST, 1839.

The leading points of comparison in rival lines of Railway are, as far as Engineering is concerned: the relative costs, grades, curves and lengths. It is to the influence which the last of these considerations should have on final locations, that I propose devoting this paper. From its apparent simplicity this subject has not, in my opinion, always received the attention its importance merits.

The graduation of a railway, after a few years, requires but little outlay to keep it in repair. The superstructure, on the contrary, is always liable to derangement and wear, especially when perishable materials are used. Thus the shorter route may cost more for graduation than the longer, and yet be kept in order at a less annual expenditure, until the interest of the capital invested in the extra amount of graduation on the shorter route equals the annual sum required for the repairs and renewals of the extra length of the longer. Still the shorter line will be passed over in less time and—what will sometimes be of equal, sometimes of greater importance—the repairs of cars and engines will be less, being exactly in proportion to the lengths of the routes,—grades and curves being considered equal.

The annual expenses of a railway may be divided into three distinct parts. 1st. The interest or prime cost of graduation, superstructure, engines, cars, buildings, etc. 2d. The repairs of the graduation and the repairs and renewals of the superstructure. 3d. Repairs and renewals of engines, cars, buildings, etc.; salaries of agents, engine-men, etc.; cost of fuel, oil and all expenditures not included under the two first heads.

The prime cost of the road itself is independent of the amount of freight

which may pass over it, but the engines, cars and buildings must be in proportion to that freight. The repairs of the graduation will not in any degree be affected by an increase of business and the annual expenses of the superstructure in a comparatively trifling ratio; but the expenses under the third head, increase with the freight and distance, and in the same proportion—hence, they are estimated at so much per ton, per mile. As a general elucidation rather than numerical accuracy is attempted, the nearest round numbers will be used. The entire cost of a double track, cars, engines, buildings, etc., necessary for an extensive business, will be assumed at $30,000 per mile, and the repairs and renewals of wooden superstructure at $1000 per mile, of double track per annum. The expenses under the third head will be estimated at one cent per ton per mile, and 100,000 tons will be assumed as the entire freight passing over the road in one year.

It appears then, that each mile of distance requires an annual outlay of the interest on prime cost, $30,000 *a* 5 per cent=1500 dollars—secondly, repairs and renewals of superstructure 1000 dollars, and thirdly, 100,000 tons at one cent, 1000 dollars;—in all $3500 per mile perannum, the in terest at 5 per cent of $70,000.

By this calculation the reduction of the distance by one mile, will justify an expenditure of $70,000, or upwards of $13 per lineal foot of road. Nothing can more clearly or forcibly illustrate the importance of making the final location with every care, for the expense of a locating party for a whole day will be paid if they succeed in diminishing the distance by a single foot—a degree of accuracy of course unattainable in practice, and an extreme case, merely adduced to show the propriety of devoting all reasonable time, labor and expense towards reducing the distance to its minimum.

It may appear to some, that this reasoning is based on the principle, that true economy requires everything to be well done at first, and it may be urged, that the scarcity of capital in this country precludes the idea of carrying out this principle to its full extent; it must, however, be distinctly understood, that the *location* only, is here spoken of—the wooden superstructure may be replaced by stone and iron, the bridge of timber by the arch of granite and the wooden sheds by substantial edifices, but a bad location, like an error in architecture, can never be remedied.

A case of frequent occurrence will show the application of these remarks. Suppose the choice to lie between two routes not differing materially in cost of construction, the shorter of whieh is inferior to the longer in grades and curves, or both;—then the longer should not be preferred without ascertaining that the grades and curvature of the shorter cannot be rendered equal to those of the longer line by the expenditure of the sum due to the difference in distance. Before adopting the longer route, the surveys ought to *demonstrate* that the length cannot be reduced by an expenditure at that rate per mile, on the distance saved by the shorter line.

It is all important to observe, that the sum assumed as equivalent to the saving of a mile in distance is to be expended on the *graduation* only.

The thorough and systematic examination of the ground absolutely necessary for a location on this principle, will be attended with some collateral advantages. Thus, when the line consists of a series of curves, a diminution in distance will generally be effected by lessening the total curvature and overcoming this diminished variation with a larger radius. In addition to these important though incidental advantages, complete surveys will often show, that a good location is as cheap or cheaper than an indifferent one which has been run out, and is to be adopted, not because it is *known* to be the best line between the termini, but because it presents no very objectionable features and is within certain limits of grade and curvature which are not inadmissable.

In fixing on $70,000 as equivalent to a mile in distance, the freight was taken at 100,000 tons per annum. Now it is clear, that if the freight exceed 100,000 tons, the expenses under the third head will increase in the same ratio, and if the freight amount to 300,000 tons per annum, we shall, for this alone, incur an annual expense of $3000, the interest of $60,000, and adding to this the $30,000 per mile, prime cost, the repairs and renewals of superstructure requiring the interest of $20,000, and we find one mile equivalent to $110,000—neglecting a slight increase in the repairs of roadway, in consequence of the additional traffic and interest on prime cost of the cars, engines, etc., required to transport the additional 200,000 tons—the latter no trifling consideration, but purposely omitted, to show those who may not have studied this subject, that $110,000 per mile, however great a sum it may appear, is a low estimate of the advantages gained by reducing by one mile the length of a road over which 300,000 tons pass annually. The saving of time is also very important. Before many years elapse, the competition among the numerous roads leading from the Atlantic to the West will render every mile of unnecessary distance a drawback of the most serious nature, for the western traveller, in addition to paying a higher fare and incurring greater fatigue, is also subjected to the loss of time, on which he, whether justly or not, almost invariably places a higher value, than on either economy or comfort.

There is yet another argument which ought to have some weight. It cannot be doubted, that the time is not very distant when the interests of the New York and Erie Railway, as well as of the country, will require a superstructure of the very best kind, at a cost of not less than $20,000 per mile of double track, and every mile now saved will of course at that time be a direct gain of $20,000.

From all these considerations we see the impolicy of increasing the distance for the sake of passing by some village or mills, unless the business thence is at least sufficient to indemnify the Railway for the one cent per ton per mile, on the *entire* quantity of freight which may be expected to

pass over that increased distance, and, even then, the loss of time is neglected. It would in many cases be cheaper to build a side track to the village or mills, and give them the use of it; and if the increase of distance exceed 2 or 3 miles, the requisite cars and engines may be furnished without charge and with very decided advantage to the general interests of the road.

The New York and Erie Railroad is, however, to furnish another avenue from the city of New York to the Western country, and although this road, like the Erie Canal, will depend principally for its income on the country through which it passes, it is scarcely possible that the western trade should form so small a fraction of the income of the New York and Erie Railroad as it has for the last 10 years, of the income of the Erie Canal. Still the western trade and travel, though a secondary consideration, are far too important to be overlooked, and every unnecessary foot of distance aid directly in diverting to Philadelphia the business which this road should secure to New York. Whether the trade and travel of any part of the line will justify any, and, if any, what increase of distance is not an engineering question, but I should earnestly recommend a very close scrutiny into any proposal to increase the distance for the sake of local business, for every such additional foot becomes a direct tax on all the freight coming from, or going to places in this or other States to the westward of this unnecessary extension. Hence the location of the Eastern division is that on which too much attention cannot well be bestowed, for a very large proportion of the trade and travel of this State as well as the entire traffic of the West must always pass over that part of the route.

Since the first surveys, the distance has, I believe, been reduced about 33 miles, equivalent, at the lowest calculation, to above two millions of dollars, and producing a saving of one dollar on every ton, from the Western States, estimating the *entire* cost of transportation at the low rate of 3 cents per ton, per mile—very little more than three-fourths of the mere *tolls* on the government works of Pennsylvania. The difference in cost of transportation arising from this diminution in distance may lead to a vast increase of freight from the West, which again renders practicable a further reduction in price, by which the extent of country tributary to the road, will be proportionally increased.

It is not easy to avoid the impression, that, on so long a route as that of the New York and Erie Railway, a few miles more or less, is no very great object. It is true that a mile bears only a very small proportion to the length of this road; still the absolute expenditure per mile, remains the same, be the length what it may: and as the business will be in some degree in proportion to the distance between the termini, the objections to any unnecessary extension may be said rather to increase with the length of the road. Thus, the addition of one mile or 1-450th of its length to this road, would be more objectionable than the addition of an equal distance

to most of the short roads in the Union, though constituting from 1-40th to 1-15th of their length.

I conclude with observing, that, in competing with its formidable rivals, the New York and Erie Railroad has, in my opinion, more to fear from its great length, than from all other causes united.

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## DR. LARDNER'S INSTRUMENTS FOR EXPERIMENTING UPON RAILWAYS AND THE MOTION OF RAILWAY CARRIAGES.

*Instrument for Detecting Vertical Deflexion.*—To test the formation and stability of the road, it was determined to observe the effects which the rails and their supports suffered by the action of the wheels in passsing over them. Mr. Wood contrived and constructed instruments for this purpose, consisting of a simple lever, the shorter arm of which was placed either under the lip of the rail itself, or under a staple attached to the rail, so that when the rail would sink, the arm of the lever would be depressed, and if the rail would rise, the arm of the lever would rise also, by the superior weight of the longer arm. Thus every motion of the rail upwards and downwards would produce a contrary motion in the opposite end of the lever, and as the arms of this lever were unequal in the proportion of about six to one, the actual vertical deflexion of the rail was exhibited on a proportionary magnified scale by the motion of the longer arm. In order to register these deflexions, which usually were produced with great rapidity and in considerable number by the wheels of a train successively passing over the rail to which the instrument was attached, Mr. Wood adopted the same method as was previously used in several other self registering machines, A narrow strip of paper of considerable length, being rolled upon a small cylinder, was gradually unrolled from it to another cylinder, and as it passed from the one to the other, it was drawn over a disc, against which a pencil was pressed, which was carried by the longer end of the above-mentioned lever. The motion of this pencil, upwards and downwards, produced by the deflexion of the rail, would, if the paper were quiescent, merely draw a vertical line upon it; but by the motion of the paper under the pencil, every separate motion of the pencil upwards and downwards, produced a waving line, the summit of each wave exhibiting the magnitude of each deflexion. Three of these instruments were constructed by Mr. Wood, with a view to expedite the taking of the observations, so that being applied to different parts of the rail, three sets of deflexions would at the same time be taken by one passage of a train.

*Instruments for Measuring Lateral and Horizontal Deflexions.*—It will be perceived that the effect of the last instrument was only to measure the deflexion of the rail downwards or upwards. After Dr. Lardner had been some time engaged in experimenting with these, he succeeded in constructing another set of instruments, capable of measuring similar effects in the lateral or horizontal direction. These instruments consisted of a compound lever by which any motion of the shorter arm was magnified fifty times, so that when the shorter arm was drawn back or drawn forward in the horizontal direction through the fiftieth part of an inch, the end of the longer arm was moved upwards or downwards, according to the direction of the motion of the shorter arm through the space of an inch. The shorter arm of this lever, bore by a hardened steel point upon a flat circular disc of steel constructed on the end of a short rod or cylinder, moving horizontally in guides. The other end of this cylinder

was presented to the side of the rail to which was attached a hardened steel point which bore upon the disc; so that the cylinder thus moving in guides was placed between the two steel points, one attached to the rail, and the other to the short arm of the lever of the indicating instrument. The longer or indicating arm was furnished with a pencil, which registered its indications on paper, in the same manner as in the instruments contrived by Mr. Wood for registering the vertical deflexions. The two sets of instruments combined rendered the means of observation of the effects of carriages upon the rails complete. It is evident that the rail could not suffer any effect which would not be felt, measured, and registered by one or both of these instruments. To the experiments made with these instruments, at least one-third of the whole period of this inquiry was devoted, and many hundred diagrams were taken, exhibiting the effects produced not only on the rails themselves, but on the chairs by which they are supported on the timbers, where timbers are used, and on the stone blocks on which other railways are supported.

*Instrument for Testing the Laying of Rails, &c.*—In addition to these tests of the effects produced upon the rails by the traffic over them, Dr. Lardner proposed to apply another which would show the state of perfection with which the rails were laid, or their state after the lapse of any length of time. It is evident that on a straight line of railway, the two rails on which the wheels of the same carriage rest, ought to be at the same level, so that the carriage may stand in a truly horizontal position. A newly constructed road ought to be laid with sufficient precision to effect this; but after being worked for any length of time, it cannot be expected to preserve it. One rail will subside more than the other, owing to the different degree of firmness of its supports, and of the ballasting beneath them; in fact the rails will lose the correctness of their relative level, and the carriage, when resting on them, will not be as truly vertical in its position as it would be on a well and newly made railway. An instrument was contrived and constructed, which, being rolled slowly along the rails, wrote upon paper, as it went, with considerable precision, the extent to which the rails of the same line departed from a common level. The operation of this instrument may be easily explained. An iron tube, of about an inch in diameter, is formed of a length equal to the gauge of the line, or the width of the rails; at each end of this are two shorter legs at right angles to it, open at their ends; thus when the intermediate tube is placed in the horizontal position, the two short legs may be brought to the vertical position; and if the horizontal tube be extended between the lines of rails, the vertical tubes will be immediately over the centre of each rail. Now let us suppose this instrument fixed to a vertical frame, and placed on wheels or rollers, which shall rest upon the rails; let mercury be introduced into it until the horizontal tube and about half of each of the vertical tubes are filled. If the rollers which support the instrument be now made to rest upon the rails, the short tubes being in an upright position, the two surfaces of the mercury in the short tubes must, by the laws of fluids, be at the same level. If the rails be not at the same level, then the mercury will stand higher in the tube which is over the lower rail, than in that which is over the higher one. If the instrument be reversed, the mercury will also reverse its position relatively to the instrument, and will still stand higher in the tube which is over the lower rail.

When the instrument is adjusted, which it may easily be by this process, so that when the rails are truly level, the height of the mercury in one of the tubes is accurately known, then every change which that column of mercury undergoes, while the instrument is rolled over the rails, will

indicate a corresponding departure in the rails from the common level, that departure being twice as great as the rise or fall of the mercury.

In order to make this instrument register its own indications, Dr. Lardner placed on the column of mercury in the tube a float, the rod of which resting above the tube, moved in guides, so as to rise and fall regularly on the surface of the mercury on which it rested, rose, and fell; to this rod was attached a pencil, under which paper being moved in the usual way, a curve was described, whose height above a datum line was always equal to half the departure of the rails from a common level.

Among the several instruments, the invention and construction of which have arisen out of this important inquiry, there is not one which has equal general utility with this self-registering level, and it is only to be regretted that its construction was completed at so late a period that it has not been applied so extensively to the different lines as might have been wished. Its use, however, will not be confined to this investigation. The advantages which it will offer as a test of the condition of a newly made line, or of the manner in which the contractor will preserve one in operation, is obvious. It will be a check, whose indications cannot be disputed, and they are indications which involve the best qualities of a well made line. It is evident that its usefulness in practice may be extended by adding to it two other instruments on the same principle, to be rolled each along the same rail. The object of these would be to register every change of level of each rail, independently of the other, in addition to the register preserved by the present instrument of the departure of the two rails from a common level.

*Instruments for Measuring the Vibration of Carriages.*—An iron tube is extended across the floor of the carriage from door to door, from which rise two perpendicular legs at each door to the height of about twelve inches. The horizontal part of this tube extending along the floor is filled with mercury, which likewise fills the legs to the height of some inches from the angle of the tube, being similar in all respects to the tube used in the instrument for recording the relative levels of the rails. The principal irregularity of motion to which railway carriages are liable, being a lateral swinging to the right and to the left between the rails, this motion immediately affects the horizontal column of mercury which fills the tube extending along the floor, and the inertia of this column causes the column in the vertical tubes to oscillate in proportion to the lateral vibration of the carriage. A float is placed on the mercury in one of the vertical tubes, which bears a pencil similar to that described in the self-registering level, which pencil inscribes on paper each particular oscillation of the mercury, and its exact extent.

This, however, is only one of several irregular motions to which the carriages are liable. Another of these is a rocking motion, arising partly from the former lateral vibration, and partly from the irregularity of the level of the rails, either side of the carriage alternately sinking and rising, either as the relative levels of the rails change, or as the conical tires of the wheels mount upon them and descend by the lateral vibration. This rocking motion would cause a body placed at either side of the carriage alternately to ascend and descend in the vertical direction through a corresponding space, and at similar intervals. This motion was measured in the apparatus in the following manner:—a syphon barometer, formed of an iron tube of nearly an inch in bore, was placed at the side of the carriage, near one of the doors. This barometer would be raised and lowered as the side of the carriage itself was elevated and depressed by the irregularity of the motion; and this alternate vertical motion being imparted to

the mercury in the barometer, the latter, in virtue of its inertia, would receive a corresponding oscillation upon the same principle as the horizontal column in the tube was affected by the lateral motion. A float was placed in the shorter leg of the barometric syphon, which was made to inscribe the vibrations on paper in the same manner as the other instruments.

Besides this rocking motion, railway carriages, like others, are liable to more or less alternate vertical shake common to the whole body of the carriage; and although it was manifest that this was the smallest in amount of all the irregularities of motion, it was deemed right to ascertain it. This was accomplished by a small self-registering syphon barometer, placed in the centre of the carriage. All these three instruments were probably mounted upon the same frame, and their three pencils were made to act upon as many discs over which the paper was moved. The rolls of paper were all moved by the same winch, which acted upon a worm and a system of wheels driven by a common band, so that all the papers moved on the respective discs at the same rate, and received upon them the inscriptions corresponding to the different motions. In front of each disc was provided a stamp, bearing upon it the letter indicating the kind of motion recorded on the paper. Thus to the disc on which the horizontal motion was written, the stamp H was printed; to that on which the vertical motion was inscribed, the stamp V was printed; and that on which the rocking motion was recorded, was inscribed the stamp R. All these punches were attached to a common rod, and moved together by the lever provided for that purpose. A person stationed at the window of the carriage at the moment of passing each quarter of a mile, struck the lever with his hand, and punched a letter on the paper which moved over each disc. These letters divided the paper into spaces corresponding to each quarter of a mile, and vertical lines were subsequently drawn from it, which resolved the diagrams thus formed into portions corresponding to each particular quarter of a mile of the road traversed.

In this manner the number of jolts of the carriage, and the nature and amount of each jolt which took place in each quarter of a mile, were registered.

So satisfactory have been the indications of this instrument, that by inspecting the diagrams the general state of the road can be with great certainty pronounced. In passing along a newly made line, for example, it is at once rendered manifest when the train passes from a cutting to an embankment, the latter being in a state of settlement, and therefore presenting more irregularity of surface. —*From Dr. Lardner's Article on the Great Western Railway Inquiry, in the Monthly Chronicle.—London Mechanical Magazine.*

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Railway Receipts.—Railway travelling generally seems greatly on the increase, and we understand the receipts of the Birmingham Company are now above 13,300*l.* per week, or at the rate of 700,000*l.* per annum. On the Newcastle and Carlisle railway, also, the traffic is so much increased that the Directors are laying down another line of rails [one line only having been laid in the first instance as now proposed for the Exeter railway to Bridgwater], as they find it absolutely requisite to accommodate the public.—*Bristol Journal*

According to the *Augsburgh Gazette* of 7th June, the preparatory works of the railroad between Pest & Presburg advancing rapidly, and the shares of the enterprise were in great demand.

Wisconsin Territory.—It is possible that, by this unauthorised publication of a business letter, we are depriving our readers of valuable and interesting facts promised by the writer, yet we trust not—as our only object in laying this before them is, *first* to disseminate correct information—as we are sure what comes from the writer of this letter may be implicitly relied on—and secondly, as a *modest hint* to numerous other gentlemen,—may we not say friends?—engaged in promoting the great cause of Internal Improvement—that we have strong, and we think *just*, claims on them for similar acts of courtesy. It is not for us alone, however, but our readers, that we urge C. N. H. and every other reader of the Journal to communicate such facts and general information, as may promote the cause in which we labor.

For the American Railroad Journal and Mechanics' Magazine.

EXTRACT FROM A LETTER, DATED

RACINE, RACINE CO., WISCONSIN TER.,
August 15, 1839.

Enclosed is the amount of my subscription for the present year, commencing with volume 9th., (new series, vol. 3, No. 1.)

I wish, hereafter, my numbers to be forwarded to this place, well enveloped in thick paper, as our mails have often to encounter very rough roads, and in some instances running streams of water, which endangers their safety.

My time has been, while in the territory, too much taken up with the duties of my profession, to allow me to give any notes, memoranda or statistical facts relative to the Internal Improvements projected here. Indeed, the territory is too new, as yet, to enter largely into these matters. I am now engaged in the construction of a common road extending completely across the territory, from Racine on Lake Michigan, to Sinepee on the Mississippi, through the southern tier of Counties. An appropriation of $10,000 was made by Congress, at its last session; to aid in its construction. Capt. Cram, of the Topographical Engineers, has the general superintendence of all the Internal Improvements projected by the government in the territory. Appropriations have been made by Congress for a road from Milwaukie through Madison, (the seat of government) to the Mississippi, ($10,000 appropriated.) This was expended last winter and this summer, on the portion of the road from Milwaukie to Madison. Other appropriations for roads, for survey of Rock River, and for survey for Railroad from Milwaukie to the Mississippi, were made by Act No. 74, (public) 2nd Session of 25th Congress. Another Act of March 3d., 1839, (3d. Session of 25th Congress) made other appropriations for the territory. These common roads are just now of the utmost importance to the growing interests of this garden spot of creation—and Railroads and Canals must for the present be superseded. The Milwaukie and Rock River Canal, however, is one of great importance to the territory. A grant of land was made by Congress, to the territory, to aid in its construction. Mr. Byron Kilbourne

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is the President of the Company, Mr. J. Lapham its Engineer. Mr. Alexander Mitchell, late of the U. S. Army, is the territorial Engineer and has been charged with the necessary surveys and examinations for the Canal route, and it has been finally located, ground broken on the 4th of July last, and certain portions are about being put under contract. I will try and send you a copy of the Canal bill as passed by the territorial Legislature last winter, and if any reports of the Company can be obtained, I will forward them to you.

I will soon, if possible, give you an analysis of the agricultural and mineral resources of the territory, its Internal Improvements, &c., &c. Mr. Wm. Jackson, who removed from your city last fall, and is a promising young lawyer, settled now at Mineral Point, will publish, this fall, a work on the resources of Wisconsin, which will, I think, give a graphic delineation of our prosperous territory. Obtain a copy—it will show how we are driving ahead in a spot which three and a half years ago, was ranged by the roving bands of Winnebagoes Menomonies and various other tribes, and which was in 1832, the scene of the celebrated Black Hawk war, when but few settlers were to be found—the only white men then here, being Indian traders or mineral diggers, in the western portion of the territory. A more fertile, healthy or beautiful country is no where to be found, than Wisconsin.

I have written the above in haste, but will soon give you a communication fit for publication. In the meantime, gentlemen,

I remain your obedient servant, C. N. H.

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We find in the Railway Times the following notices of the evidence before the Select Commmittee on Railways. Although intended for another medium these remarks cannot but find their application with us. We have several times proposed to ourselves the subject of the "Minor morals of Railroads" and have as yet found nothing so much to the purpose as the following. We shall continue the articles, as found in the Railway Times.

In adverting last week to the evidence taken before the Select Committee on Railways, we expressed our firm belief that the object proposed by the Committee in recommending the insertion into all Bills then before Parliament of a clause bringing the undertakings to which they relate within the provisions of a future general Act, had reference to minor points of management rather than to any contemplated infringement upon the rights and privileges of the Railway Companies; and we stated at the same time that the evidence hitherto published appeared to point at the necessity of some uniform system in these comparatively trivial, but nevertheless most important, arrangements. We now proceed to notice a few of the details which range under this head, omitting until the production of further evidence, the consideration of one or two subjects which will be more appropriately treated of when the whole of the case laid before the Committee shall be developed.

One of the principal subjects which appear to have engaged the attention of the Committee, is that of bye-laws, with a view, it would seem, to the introduction of some uniform system, and to the supervision of some

competent tribunal. With respect to the former point, most of the witnesses express an opinion that uniformity would be highly desirable, while all of them agree in admitting that the establishment of a superintending power in this matter would be very advantageous to both parties, namely, the Companies and the public. The representatives of the Birmingham Company state that they are exceedingly anxious, instead of being left to the present uncertainty, to have their bye-laws defined, although they express a doubt whether it is possible for Parliament in this early stage of the Railway system to lay down such laws with sufficient precision. In like manner Mr. Moss, on the part of the Grand Junction Company, and Messrs. LAURENCE and BOOTH on that of the Manchester and Liverpool, although they state that these Companies have no bye-laws [forgetting that although not so in name, their travelling regulations are substantially the same], can see no objection to the supervision by some proper tribunal, and if necessary, the disallowance of such enactments. Mr. SIMS and Mr. SAUNDERS on the part of the Great Western Company are of the same opinion, and add, that in their Bill [then] before Parliament there is a clause the same as that which Mr. REED of the Southampton, states has been introduced into the Bill for the Gosport branch of that undertaking, obliging the Company to submit their bye-laws to one of the judges of the land, or one of the Courts of Quarter Sessions. This proviso is similar to one in the new Bill of the Birmingham Company, which renders it necessary that every bye-law shall not only receive the approval of a judge, but be published in the *Gazette* and two country newspapers, at least one month previous to coming into effect.

Closely connected with this subject, and flowing as it were from it, is the due management of the Companies' servants; and the Committee appear to have paid considerable attention to this branch of the inquiry, especially with respect to the engine-men, upon whom so much depends. The witnesses, particularly Mr. Moss, lament exceedingly the unfitness of many of the persons who engage themselves for this responsible duty, the great demand for engineers rendering it impossible for the Directors to find at all times, individuals fully competent. Mr. Moss recomends the appointment of a Government Board [to be paid by the Companies] whose duty it should be to examine applicants, and grant certificates qualifying them to take out licenses, in the same manner as pilots are examined by the Trinity Board, the Companies employing such persons not to be responsible for any accident occasioned by a disobedience of orders on the part of these licensed engineers, although liable in every other instance. At present, says Mr. Moss, the Companies appoint the best person they can get: he disobeys their orders, and the public come upon the Companies for damages. Mr. Moss meets an objection which might be urged against his plan, namely that this freedom from liability would render the Companies less careful whom they engaged, by recommending that the engineers should find security, which would render them more attentive, and states that the Companies would not be disinclined to allow a higher rate of remuneration to a better class of persons, which would render them afraid of losing their situations. Mr. CREED says the examination of engine-men has never occurred to him, but he is satisfied that every Company would be ready to adopt any arrangement which would give confidence to the passengers. All the witnesses represent the difficulty which the Directors have in keeping these engine-men to their duty, and Mr. LAURENCE refers to one occasion where the men left their employment *en masse*, and the Company were obliged to put up with the best substitutes they could find, to the great damage of the machinery, although fortunately no accident occurred. Several of the wit-

nesses are of opinion that the punishment of carelessness and other offences [such as leaving their employment without notice,] by the magistrates, independent of the Directors, would be of advantage. Mr. LAURENCE and Mr. SAUNDERS in particular, think that if engineers or persons engaged in a confidential capacity were to be taken before the petty sessions or some competent tribunal for neglect of duty, even though accidents should not have occurred, it would produce a strong moral effect upon them beyond that which now exists as to the necessity of attention.

The regulations of the Companies with respect to passengers suspected of contemplated fraud seems to have been much canvassed by the Committee. Such of our readers as have travelled on the Birmingham Railway will recollect that it is the practice to collect the fair tickets at the last station but one upon the line. A similar plan is followed on the Southampton line, whereas on the Grand Junction and Great Western Railways the tickets are collected before the train starts. This latter method is allowed even by those who follow it, to give room for much fraud; for, as Mr. REED observes with respect to the Southampton line, a passenger might take out an eighteenpenny ticket to Kingston, and as the guard of the train could have no means of knowing what ticket the passenger had, he might proceed for one shilling and sixpence to the end of the journey. To be sure there might be, as on the Great Western line, carriages exclusively set apart for particular stations, but then, as Mr. REED remarks, in answer to a suggestion of the kind, there might be only three or four passengers for that particular station, which would involve the necessity of taking a great many more carriages than need be. One disadvantage inseparable from the other plan is this, that a person wishing to defraud the Company cannot be detected until he has arrived at the end [or nearly so] of his journey, which is of course all that he desired. It was therefore deemed necessary by the Birmingham Company to enact a very stringent law on this point, rendering a person who could not, or would not, produce his ticket, liable to a penalty of 40*s.* in addition to the payment of the fare, and in default to be detained and taken before a magistrate. It has been objected to this regulation that it confers powers greater than those possessed by the proprietors of stage coaches in similar circumstances, and some members of the Committee appear to entertain considerable hostility to it. In the case of the Birmingham Company, however, all objection will soon be at an end, for in the new Bill there is a clause which does away with the penalty and only authorizes the Company to detain a passenger and take him before a magistrate in the event of his not either paying the fare or giving security for it.—With all submission we think the Railway Companies ought not to be reduced to the level of coach proprietors in this particular, but rather that the latter should receive more efficient protection against so disgraceful a species of swindling.

There is, it appears, an excellent arrangement in existence upon the Grand Junction Railway, the adoption of which the Committee seemed disposed to recommend. At every station there lies open upon the bar a book in which persons are requested to write down any complaint they may have to make, a copy of which book is laid before the Board at their weekly meetings without the power of concealment. With Directors determined to redress all grievances upon their line a plan like this could scarcely fail to ensure civility and attention from inferior officers. The same plan is nominally adopted in part on the Great Western line: that is, there is a book kept at Paddington, but it does not appear to be sufficiently, if at all, exposed, and no person has ever made an entry in it.

There are various other points to which the attention of the Committee

has been directed with a view evidently to some general enactment, such as the fencing of the several lines to prevent the straying of cattle; suitable compensation for damage by fire; the regulations affecting the transmission of carriages and horses; and the facilities for the running of other engines on the lines. To these we shall advert in a future number. There is, moreover, a good deal of evidence with respect to the establishment of a Royal Commission, but as the object contemplated in the institution of such a Board appears to be principally to decide upon the merits of competing lines, and to determine in cases of difference between Railway Companies and land owners, it cannot, of course, bear very directly upon the first Report of the Committee as affecting those Companies at present before Parliament for amended Acts. We shall, nevertheless, take an early opportunity of laying this part of the evidence before our readers, with some comments upon the scheme.—*Railway Times.*

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The Railways of Massachusetts.—The Great Western Railway between Worcester and Springfield is fast being made ready for use. The rails are laid for the greater part of the whole distance, excepting for short intervals where vigorous operations are prosecuted for completing the grading and superstructure. It is expected that communication will be opened as early as the beginning of October.

The first division of this way, extending from Worcester to the height of land between the sea and the Connecticut river in Charlton, about 14 miles westward, has been constructed under the superintendence of Capt. J. Barnes, and has been for some time so far finished as to be traversed by the car propelled by *man power.* This portion exhibits a specimen of the magnitude of the great work. The country is broken with deep valleys, or thrown into ridges which seem to present almost impassable barriers. Yet the skill of the engineer has carried the iron-pathway over a surface so rugged and difficult as to appear impracticable to the eye uninstructed by the evidence of actual construction. The traveller sees the road, breaking through the hills and striding across the ravines, with equal admiration and astonishment at the boldness of the design and the success of the execution. The whole of the work is of the most excellent character; wide excavations through rock and earth, and long embankments sometimes rising more than sixty feet above the surface, the solid masonry and the firm structure, bear testimony of the excellence of the construction, and the power of human science and labor in overcoming the obstacles of natural difficulty.

West of the Connecticut river, it is understood that the road is under contract, and may be completed to the line of the State within two years.

The Norwich road is rapidly advancing. The cars now pass from Norwich to Plainfield, about twelve miles. Workmen are engaged in laying the rails from Worcester towards the south, and at intermediate points between the extremities. The whole road is graded, and it is said may be opened during the month of October, for travel over the whole extent.

The Eastern Railway will be extended to Ipswich in November next, and opened to Portsmouth by the 4th of July following.---*National Ægis.*

Eastern Railroad.---This Railroad has now been opened for public travel one year. The Essex Register states a number of interesting facts, illustrating the success of the enterprise. It appears from this statement, that on the commencement of the work, the estimated number of passengers annually transported on the route was 116,700, of which it was estimated that 32,000 were conveyed to and from places beyond Salem, and

84,700 between Boston and Salem, Lynn and Marblehead, and that this number would be doubled by offering the advantages of Railroad travel.

The actual number conveyed on the Railroad, in the year from August 28, 1838, to August 28, 1839, was 287,000, or two and a half times the number estimated to be conveyed before the road was opened; and 55,000 more than it was estimated by the projectors of the Railroad, that there would be, when the road should be opened. The greatest number of passengers conveyed in any one day was 7,006, on the 4th of July last, and the next greatest number, 2,100 on the 5th. The greatest weekly travel was 13,937 in the first week in July, the next greatest 7,631 in the week ending August 24, and 7,531 in the last week in May.

The least weekly travel was 3,220, in the last week in December, and the next less 3,600 in the first week in February. The work for the extension of the road to Newburyport is rapidly advancing, and particularly the tunnel for carrying it under the central part of the city of Salem.—*Advertiser.*

By the preceding paragraphs from eastern papers, we learn what Massachusetts is doing in the way of extending her works for securing the business of the West, and facilitating travel to the East.

The natural inquiry of a reflecting New Yorker, on reading them is—what is New York doing? To which he may, with truth, as well as deep mortification, reply—New York, the Empire State, is engaged in *putting men out of, and into office!*

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SEMI-ANNUAL REPORT OF THE DIRECTORS OF THE LA GRANGE AND MEMPHIS RAILROAD COMPANY.

(Continued from page 64.)

*Contingencies.*

| | | |
|---|---|---|
| Printing account, | 569 39 | |
| Postage account, | 20 82 | |
| Office expenses, including rent, firewood, stationary, &c., | 235 31 | |
| Other contingencies, including salaries of officers, &c., | 8,186 10 | |
| | | 9,011 62 |
| Profit and loss, interest on sundries, &c. | | 2,884 78 |
| | | $190,279 61 |
| Total amount of receipts as above, | | $181,933 12 |
| Disbursements as above, | $173,311 22 | |
| Cash on hand, July 1st, 1839, | 95 00 | |
| Notes on hand, | 7,546 00 | |
| | | 181,933 12 |
| The Company owe in Notes, payable in the banks at Somerville, Memphis and La Grange, and to individuals, | | $32,430 00 |
| Due to individuals, not closed by note, | | 16,131 33 |
| Per centage retained, which will fall due when the contracts are completed, | | 15,833 00 |
| | | $64,394 33 |

| | | |
|---|---|---|
| We have on hand---Cash, | $95 00 | |
| Due from banks state bonds on deposit and from individuals, on account, | 46,765 00 | |
| Notes of individuals, | 7,546 00 | |
| All of which, if available, would more than pay the debt now due, but including the per centage retained, would leave a deficit of | 987 83 | |
| | | $64,394 33 |

Besides the assets above mentioned, we have due from individual stockholders, including interest upon the stock, $165,690 00
State Bonds now due, 31, 250 00

$196,940 00

From the above must be deducted the insolvencies and unavailable credits.

The actual cash transactions for the last half year have been very limited. The amount on hand on the 17th January last, was $1,000 00
Received from the 17th January to July 1st, 1,741 87

$2,741 87

| | | |
|---|---|---|
| Paid out from 17th January, | $2,645 87 | |
| Cash on hand, July 1st, | 95 00 | |
| | | $2,741 87 |

To the debts may be added the estimates of the second quarter, which had not been audited when the Cashier reported, together with the expenses of laying the superstructure, (for which see Engineer's report.)

At the organization of the present Board, in January last, the debts against the Company, including the estimates of the last quarter of 1838, amounted to about $85,000, four-fifths of which constituted an immediate demand on the Treasury. To sink this debt was our first consideration. Accordingly a negociation was opened with the banks for a temporary loan; which resulted in obtaining from the Farmers and Merchants' Bank of Memphis $14,500, at 8 per cent., payable 9th March, 1840, the Company executing its corporate notes and depositing State Bonds as collateral security:---From the Branch of the Bank of Tennessee at Somerville, $12,261, at 6 per cent., payable 1st November next, on company's notes with endorsers, and filing Bonds to that amount as collateral security; and from the Branch of the Planters' Bank at La Grange $1000, at four months, upon the same terms,*---making $27,761. These sums, with the collections from stockholders, State Bonds, and the transfer of debts and accounts to contractors, &c., at a small discount, enabled the Directory to keep up the disbursements with the accumulating debts, or nearly so.

Every effort will be made to finish 15 miles this year. Col. Charles Potts, the Chief Engineer, proceeds to Philadelphia to negociate for the Railway Iron, Locomotives, &c. Our reliance to purchase materials, mainly depends upon the sale of our State Bonds, and the interest being payable at Nashville, they are not at par in the Northern market; five and a quarter per cents, payable at Nashville, being not quite equal to five per cent. bonds payable at New York. The propriety of applying to the Legislature for the privilege of surrendering the present bonds, and obtaining others, with the privilege of directing the payment of the interest at any

* It is due to the Planter's Bank to observe that she had previously purchased State Bonds at par to the amount of $31,250, and proffered to loan us $3000, which she considered was equivalent to the accommodation of the other two Banks.

point the Board should designate, is respectfully recommended. If the interest on our Bonds was payable in London, they would now command a premium.

We cannot close this report without alluding to another matter which has served to embarrass our movements. We are threatened with a very unexpected bill of expense for the right of way. When the Road was ready to let, at the close of the year 1836, the enthusiastic public spirit, which seemed to pervade the whole community, forbid the idea that exorbitant damages would be claimed by any of the proprietors of land on the route. And such was the anxiety to proceed with the grubbing and grading, that few releases were obtained prior to the permanent location of the Road. The consequence has been, that we have been placed in an unequal position to all those who imagined themselves agrieved, and compelled generally to submit to the assessment of a jury of five, without many of those guards which protect as well the rights of corporations as individuals, in the ordinary mode of administering justice. That a few proprietors have sustained slight damage by the Road, is probable; but nine-tenths of them are unquestionably benefitted. And it behoves every liberal minded citizen, to discourage these extortionary claims. There is not a tract of land on the whole line that has not advanced in value from 25 to 100 per cent. in consequence of the location of the Road through it. No fact is more generally admitted. And how any person can expect to obtain damages for benefits conferred is a mystery. The charter expressly provides that the jury shall take into consideration the benefit the Road will be to the owner and the tendency it will have to increase the value of the land.

The Charleston and Hamburg Railroad, 136 miles in length, did not cost the Company a cent—and we are mortified that we cannot bear testimony to a similar liberality. Respectfully submitted,

EASTIN MORRIS, *President.*

*La Grange, July* 23, 1839.

ENGINEER'S REPORT.—TO THE PRESIDENT AND DIRECTORS OF THE LA GRANGE AND MEMPHIS RAILROAD.—*Gentlemen*:—It gives me great pleasure, in the discharge of my duty, to be able to report to you at your present meeting the favorable progress with which the construction of the Road is going on, particularly that portion of it laying between Germantown and Memphis. The hands which have been hired and set to work laying down the superstructure, now that they have become initiated and acquainted with the respective duties assigned them, are now laying down, upon an average, a rod per day to each hand on the job. Although the circumstances under which these hands were collected and hired, were such as to make it necessary to pay the highest wages for them, the result notwithstanding shows the measure to be decidedly more economical than would otherwise have followed by the acceptance of any of the propositions from individual contractors. The laying down of the railing was commenced on the 21st of May last with about 15 hands, and has been going on since that time without other than the ordinary intermissions, the number of hands, however, increasing daily. On the 24th of June the number was 32, including boys and women, which is the number at present, no further addition having been made since that. From the 21st of May to the 24th of June, there was laid down 388 rods of the superstructure, and the number of days work required to complete this amount of work was 596, making an average of 65-100ths of a rod per day to the hand. It will be understood that this average embraces the time, when all the hands

are wasting much of their time in learning and acquiring a knowledge of a business entirely new to them. For the last month the hands have so improved as to average per each hand a rod per day. The work, also, is well put together; and I cannot omit this opportunity to express to you my entire satisfaction in the ability and energy with which Capt. Wollard has discharged his duties as superintendent of this portion of your important work. That you may form some estimate of the economy in laying down the superstructure as now pursued, I have addded the following calculations:—We now have 32 hands on the Road engaged in laying down the Railing and other duties appertaining thereto, which cost us for their time 24½ dollars per month. The Superintendent receives 52 dollars per month. The keeping of the hands may be estimated at 8 dollars per month each. The other contingent expenses may be computed at 150 dollars per month. The Company having no teams of their own it becomes frequently necessary to hire them during the month for hauling and for other purposes. Hence the expenses, per month, will stand thus:

| | |
|---|---|
| 32 hands at 24 1-2 per month, | $784 00 |
| 1 Superintendent, | 52 00 |
| 33 hands boarding, at 8 per month, | 264 00 |
| Contingencies, | 150 00 |
| Total, | $1250 00 |

I have already stated that the hands now lay down about one rod of track per day to each hand, or about 700 rods per month in the aggregate. Hence it cost the Company $180, nearly, per rod. This is one dollar per rod less than the lowest bid that has been laid before you for acceptance. The Superstructure that has been laid down has been of Cedar timber. It cannot be expected that the same progress will be made when the Oak is to be handled and put down. A proposition is herewith presented from Mr. Coe, of Somerville, to lay down a portion of the Superstructure. I should not consider Mr. Coe's proposition out of the way, if the filling up of the track was included. He would be required to work upon the Oak timber altogether, and as much of this timber is very much warped and sprung, considerable time and labor would be required to redress it so as to put it together in a workmanlike manner.

Respectfully submitted, by your most obedient,

CHARLES POTTS.

*La Grange, July 17th,* 1839.

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THIRD SEMI-ANNUAL REPORT OF THE ENGINEER OF THE CENTRAL RAILROAD AND BANKING COMPANY OF GEORGIA, TO THE PRESIDENT, DIRECTORS AND STOCKHOLDERS.

ENGINEER'S DEPARTMENT OF THE
CENTRAL RAIL-ROAD, May—, 1839.

*To W. W. Gordon, Esq., President.*

SIR—I have the honor to present you with the third Semi-annual Report of the condition and progress of the work under my charge.

Since the date of my last report, contracts for grading have been extended to a point 133 miles from the city, and opposite the town of Sandersville, which place the road approaches within four miles.

The road bed is completed for a distance of 114 miles, and a contract is made for a bridge over the Ogechee river.

The track is laid, and the road completed 76 miles, and the laying of

the superstructure is in constant progress, at the rate of about one mile per week.

The site of the 80 mile depot has been designated, and preparations are now making to erect a large store-house for the receipt and forwarding of produce and merchandise. This will be completed early in the month of July.

The buildings at the depot in this city are in a state of forwardness, and will be urged on to completion as rapidly as materials can be procured.

By a reference to the last report, you will perceive that 35 miles of grading, and 30 miles of superstructure, have been accomplished within the last half year.

The line will be definitively located and ready for contract to the Oconee river, a distanee of 148 miles, in six weeks from the present time.

It affords me pleasure to inform you, that the tedious and laborious examinations of the country from the Sandersville summit to the Oconee river, have resulted in the discovery of a line, altogether more favourable, both in respect to allignment and cost of construction, than we had reason to expect. We make the descent to the Oconee valley, as I have before mentioned, by means of one of the prongs of Sand-Hill creek. This stream has many branches, which flow out of a section of country very broken and hilly. It was indispensable that several of these branches should receive an instrumental examination, in order to obtain full data for a judicious selection. This labor has been most thoroughly performed; and every route presenting any claims to favor, has been examined.

To ensure the adoption of the most advantageous position for every part of the line, in a country of such complicated topography, it was deemed necessary to run cross sections at short intervals throughout the whole extent of the valley, which, when laid down on a map, would present a perfect analysis of the topographical features of the section under examination, and afford the data for projecting a location, without the least apprehension of overlooking the most advantageous route of which the country was susceptible.

I am perfectly satisfied from experience, in several instances in the course of the surveys for this road, that a great saving may always be made, and great improvements in location, by pursuing the above plan in all complex and difficult portions of the line.

The surveys of the line from the Oconee to the Ocmulgee had just been completed at the date of my last report. The maps, profiles, and estimates were soon after made up, and the result will be found in a subsequent part of this report. I will however remark, in relation to that portion of the line, that, as much of it is of a character similar to the line down Sand-Hill creek, a similar course will be pursued in making the final locations; and we may reasonably expect that in establishing the line with precision, many improvements may be made.

Our final location to the Oconee river, shortens the distance to that point from previous surveys, three miles; making the total distance to Macon 193 miles, provided no change is made in the length of the line between the Oconee and the Ocmulgee rivers.

The precise direction in which the line will enter the city of Macon, has not been determined. It is presumed that no benefit would result from hastening the decision of this question.

I am satisfied that in the excavation of the western division of the line, no rock will be encountered, and that for the most part the earth will be of easy removal.

In the grading, we have during the last half year, been as usual on this

work, fortunate in having contractors generally responsible and faithful. I am pleased to be able still to say, that we have not, since the commencement of the work, had a contract forfeited or abandoned before completion.

A few weeks since, some disturbances originating from sectional differences among the labourers; interrupted for a short time, the harmony which had previously prevailed throughout the line, this has led some of the contractors to resort to the employment of blacks altogether; and I am much pleased to perceive a disposition on the part of several of the planters residing along the line, to engage in contracts; I have no doubt the effect will be, to enable us for the future to keep up a more uniform scale of operations during the whole year, and also to render the work more popular, by diffusing the benefits attending its construction, more generally among our own citizens, than if the labor were performed by strangers.

That negro labor is perfectly adapted to the construction of works of internal improvement, is now a well established fact; and when this fact comes to be more generally acted upon, the public works of this section of the union will be placed on a basis that will, in a great degree, exempt them from the effects of the fluctuations and vicissitudes in the financial affairs of the country, so detrimental to such undertakings elsewhere.

So far as my knowledge on the subject extends, I have found that such of our citizens as have engaged in contracts, have, in nearly every instance, realized fair profits, and have generally been desirous of continuing in the business.

In relation to our plan of superstructure, I am still satisfied that we have adopted the best mode of applying the "plate rail."

It gives me pleasure, however, to say, that in the late resolution of the Board, adopting and ordering a large quantity of the edge rail of the inverted T pattern, they have obviously consulted the best interests of the Company; for although examples are not wanting to show, that a good road, capable of sustaining a great amount of transportation, may be made with the flat bar,—yet it is almost universally conceded, that the extra cost of the edge rail is amply repaid by the saving in repairs of the road and machinery, and by the increased comfort to the passengers.

We propose to use this rail in connexion with our present longitudinal timbers—to be laid along the centre of the top surface, and confined by chairs at the joinings, and intermediately by brad spikes. Having a string piece of so large dimensions, we are enabled to use a rail of much less weight than when it is laid only on cross ties. The rail we have adopted will weigh about 32 lbs. per yard, or about 51 tons per mile, exclusive of chairs and spikes. The wooden structure to be the same as at present, excepting the top ribbon. *For a description of it, see first report.*

The iron already on hand will extend the track about 100 miles. An additional quantity is ordered to be delivered in the fall, sufficient to reach about 40 miles further, and as the grading for that distance will be finished by the time the iron is received, we may reasonably expect the road to be in use from 135 to 140 miles from this city early in the next season.

The following shows the expenditures on account of the road up to May 22d, 1839:

| | | |
|---|---|---|
| For Engineering, | $90,334 | 18 |
| Grading, including bridges and culverts, | 474,238 | 41 |
| Superstructure, | 110,312 | 20 |
| Iron rails, spikes and plates, | 150,565 | 33 |
| Right of way, houses and lots, | 12,634 | 50 |
| Carpentry, | 19,864 | 68 |

| | |
|---|---|
| Smithry, | 12,026 59 |
| Negroes, | 922 25 |
| Locomotive Engines. | 31,241 31 |
| Lumber, | 27,924 32 |
| Iron for Smithry, | 17,409 21 |
| Teams and Forage, | 18,645 33 |
| Expenses of Transportation, | 4,193 53 |
| *Repairs of road, | 2,433 36 |
| Implements, | 27,187 64 |
| Railroad Cars, | 16,729 34 |
| Depot at Spring Hill, | 4,108 78 |
| Brick yard, | 1,624 25 |
| Incidental Expenses, | 31,000 10 |
| Total amount expended, | $1,053,395 31 |
| Of the above amount the Company have on hand Teams, Implements, Forage, Provisions, Lumber, Iron, Coal, &c., say $10,000 | 10,000 00 |
| Nett expenditure, | $1,043,395 31 |

As I have before remarked, the work, for the first 17 miles, was done on the Company's account, and in the several items of cost in the foregoing table, that portion of the work is of course blended with the part which has since been done by contract.

The following is a statement of the cost of the grading and superstructure, exclusive of iron from the 17th mile upwards:

| | | | |
|---|---|---|---|
| Grading | Excav'n and embank't | 224,704 66 | |
| | Grubbing and clear'g, | 30,501 80 | |
| | Culverts and bridges, | 12,524 20 | |
| | Road crossings, | 689 75 | $268,420 41 |
| Superstructure | Timber, | 55,443 37 | |
| | Laying and filling track, including turn outs and Water Stations, | 43,307 79 | 98,751 16 |
| Right of way, | | | 5,985 45 |
| | | | $373,157 02 |

The following is an estimate of the cost of the whole road, including expenditures already made, and the amount required to complete it to Macon.

That part of the line between the Oconee and the Ocmulgee, as I have before remarked, has only been approximately located, and it may be expected, that on a definite and careful location, such improvements may be made as to reduce somewhat the cost. I state the estimate, however, without making any allowance for improvements:

ESTIMATE.

| | | |
|---|---|---|
| Amount already expended, | | $1,052,395 00 |
| Amount required to complete the grading to the end of present contracts, 133 miles, | 93,000 00 | |
| Timber for superstructure, | 55,000 00 | |
| Laying do. and filling track, | 45,000 00 | |

* This item of repairs is occasioned by having to re-lay a portion of the track, in consequence of first using connecting plates of Cast Iron, which were found to be unfit for the purpose.

| | | |
|---|---|---|
| Iron for 34 miles, [edge rail] - - | 122,400 00 | |
| "Turn outs" and Water Stations, - - | 2,500 00 | |
| Right of way, say - - - | 3,000 00 | $320,900 00 |
| To complete the grading from the end of present contracts to the Oconee river including bridge over that river, [15 miles] - - - - | 108,262 00 | |
| Land damages, say - - - | 1,000 00 | $109,262 00 |
| Grading from Oconee to Ocmulgee, [45 miles.] | | |
| Excavation and embankment, - - | 332,775 00 | |
| Culverts, - - - - - | 11,346 00 | |
| Bridges, including one over Ocmulgee, | 23,000 00 | |
| Grubbing and clearing, - - | 17,507 00 | $384,628 00 |
| "Turn outs" and Water Stations, - - - | | 5,000 00 |
| Land damages, say - - - - - | | 10,000 00 |
| Superstructure 60 miles, with edge rail, at $6,400 per mile, - - - - | | $384,000 00 |
| | | $2,267,185 00 |
| Add for Engineering and contingencies, - - | | 32,815 00 |
| Total estimate, - - - | | $2,300,000 00 |

In the various schemes and speculations that have lately been presented to the public, on the subject of the channels to be taken by the South-Western trade of this Union to reach the Atlantic, it has been customary to leave this Railroad entirely out of view. Whether this has been induced by a belief that the road itself would not afford a means of conveyance for the produce, merchandise and passengers, equally good with other projects in vogue, or whether it has arisen from a supposition that the city at its eastern terminus is not an eligible place for the great mart and depot of the South Atlantic States, or from a combination of both these causes, I am not able to say; but lest such an impression may have found its way into the counsels of the advocates of internal improvement, we will examine the merits of the route of which this road is to form an important part, and compare it with others at present occupying the attention of the public.

It has long been considered a desideratum to effect an internal communication by means of a Railroad, between the State of Ohio and a Southern Atlantic port. Charleston has been selected as the great port of debouche, and two routes have been before the public, in a position of rivalry for effecting this great communication. Both are common as far as Knoxville in Tennessee; here they diverge; the great Louisville, Charleston and Cincinnati route takes the French Broad river, and passing through Ashville, N. C., and Columbia, S. C. joins the South Carolina Railroad at Branchville, and pursues that road to Charleston, making a total distance from Cincinnati of about 720 miles. The other route, which we will call the "Georgia route," pursues the Hiwassee Railroad to the Georgia State line, thence by the Westernand Atlantic Railroad it reaches De Kalb county, thence by the Georgia Railroad via Madison and Greenborough to Augusta, and by the South Carolina road, it ends at Charleston----distance from Cincinnati about 750 miles.

These two, have hitherto been considered the great rival routes; but, as

the probability of the Louisville, Charleston and Cincinnati road being continued farther than Columbia, S. C., appears to be fast fading away, the "Georgia route" is left in possession of the field, unless the route via Macon to Savannah, is found to possess sufficient advantages to entitle it to a claim to public favor. We will designate this last as the "Central route," and make a brief comparison between it and the "Georgia route."

Taking the eastern terminus of the Western and Atlantic Railroad in De Kalb county, as a common point, the distances respectively to Charleston and Savannah, will be as follows:

GEORGIA ROUTE.

From the eastern terminus of the Western and Atlantic Railroad in De Kalb county—

| | | | |
|---|---|---|---|
| To Madison, - - | Georgia Railroad. | 65 | |
| From Madison to Greensborough | | 25 | |
| From Greensborough to Augusta | | 79 | |
| Erom Augusta to Charleston, | S. Carolina R. R. | 137 | ----306 |

CENTRAL ROUTE.

From the eastern terminus of the Western and Atlantic Railroad in De Kalb county----

| | | | |
|---|---|---|---|
| To Forsyth, - - - | Monroe Railroad. | 69 | |
| From Forsyth to Macon, - | | 25 | |
| From Macon to Savannah, - - | Central Railroad. | 193 | 287 |
| Difference in favor of Central route, - - | | | 19 |

This difference in distance is so small as to be of little consequence. Let us however carry the comparison a little further, and examine the relative capacity for transportation, &c., of the two routes.

The Central Railroad presents an uncommonly favourable profile having no inclination of grade exceeding 30 feet per mile, and no curvature on a less radius than 2000 feet. The allignment consists for the most part, of straight lines; in some instances 16 miles in extent---and is in all other respects, capable of sustaining as much trafic as any other Railroad in the Southern States.

The Monroe Railroad is finished, and now in use from Macon to Forsyth, 25 miles, and is similar in point of allignment and grades, to the Georgia Railroad. The remainder of the distance to the State road in De Kalb county, is known to possess uncommonly favorable features for a Railroad route. Taking the "Georgia route,"—the South Carolina Railroad, although generally free from frequent curvatures, has several of less radii than 2000 feet. The maximum of inclination of grade is 36 feet per mile, and the road is moreover burdened with an inclined plane requiring a stationary steam engine.

The Georgia road has a great number of curves, and a small proportion of long straight line, though none of the curves are on radii of much less than 2000 feet. The road is in all other respects excellent—completed as far as Greensborough, 79 miles. The distance thence to Madison, 25 miles, is under contract, and it is presumed may be compared with the part finished as to grades and curves. From Madison to the Western and Atlantic road, the route is most difficult, and the construction will be very expensive, though it is supposed a location is practicable without exceeding an ascent of 36 feet per mile.

To compare the cost of the two routes, the "Georgia route" may be estimated as follows:—

| | | |
|---|---|---|
| From the eastern terminus of the Western and Atlantic road to Madison, - - | $1,200,000 | |
| Madison to Greensborough, - - - | 600,000 | |
| Greensborough to Augusta, - - - | 1,200,000 | |
| South Carolina Railroad, - - - | 3,000,000— | $6,000,000 |
| CENTRAL ROUTE. | | |
| Central Railroad, - - - - | $2,300,000 | |
| Macon to Forsyth, - - - | 450,000 | |
| Forsyth to Western and Atlantic road, - - | 1,000,000— | $3,750,000 |
| Difference in favor Central route, - - | | $2,250,000 |

In the above statements, great accuracy either in distances or amounts, is not aimed at; but whatever errors there may be, will not affect materially the result of the comparison.

It will of course be admitted that the expense of keeping the roads in repair on the Central route, will not exceed that of the other, as the proportion of deep cutting and heavy embankments, is far less on the former than the latter.

It follows then, that with the same amount of business; the stockholders of the Central route may reduce their rate of freight, to at least one-third less than those of the Georgia route, and realize equal profits.

In relation to the merits of the city of Savannah as a commercial mart, I will only remark, that the bar at the entrance of the river is not excelled by any south of the Potomac. I have seen ships drawing 20 feet water pass over it.

The city is less than 20 miles from the ocean, and ships carrying 2000 bales of cotton have loaded at the wharves, and by dropping down 3 1-2 miles may take in 2800 or upwards.

It is indeed unnecessary to say more in favor of Savannah as an outlet for the great Southern staple, than to mention the fact, that her exports of cotton have for several years past exceeded those of Charleston, by many thousand bales per annum.

On the score of health, it may be confidently affirmed, that no city in the Southern States can show more favorable bills of mortality in proportion to the population, for the last twelve years, than the city of Savannah.

A charter was granted at the last session of the Legislature, for a branch Railroad to connect this road with the city of Augusta; and in compliance with a request from a committee of the citizens of Burke county, a survey was made under the direction of this department, for the purpose of ascertaining the cost, &c. of that portion of the route between the Central Railroad and Waynsborough. A report with estimates and maps in detail, shewing the result of this survey, was communicated to the above named Committee. As that report has not been published, the following synopsis may be made:

The route surveyed diverges from the line of the Central Railroad about 3-4 of a mile below the point where this road crosses Big Buckhead creek, and pursues the general direction of the valley of this creek for about 13 miles, to Rosemerry creek—here bending to the right it assumes the dividing ridge between the waters of Buckhead and Briar creek, and follows this ridge over a moderately undulating country to Waynsborough.

The distance is 22 1-2 miles—which, added to the distance from the point of junction to the city of Savannah, 79 miles; and the distance from Waynsborough to Augusta 32 1-2 miles—makes a total distance of 134

miles from Savannah to Augusta by Railroad, being only 12 miles longer than the direct stage route.

There will be no inclination of grade exceeding 30 ft. per mile, and no curvature on a radius of less than 2000 feet.

The cost of the road from the Central Railroad to Waynsborough is estimated at $182,800, exclusive of Locomotive Engines, Cars, &c.----and contemplating a superstructure similar to that of the Central road, with a plate rail supported by longitudinal string-pieces.

The citizens of Savannah, by an unanimous vote in town meeting, requested the corporate authorities to subscribe $100,000 to the Capital Stock of this road----and should the city of Augusta take a like sum, there is every reason to expect that the large resources of the county of Burke, and the public spirit of its citizens, with those of the two cities, will supply the remainder of the required funds, and that we shall soon see this branch in progress.

That it would be of great advantage to the cities of Augusta and Savannah and the intervening county, and add greatly to the business of the two Railroads already in progress, no one will doubt, and that the estimated cost bears a small proportion to the great advantages and revenue that might be expected, will also be readily admitted.

In thus enumerating the advantages to be reasonably expected to result from the completion of the Central Railroad, it is with a view of showing to the Stockholders, that although they have to traverse a great extent of barren and unproductive county with their road, before they can reap large returns for their investment; yet the cost of making the road per mile, when compared with that of most of the railroads in the country, is very small, and the road will be maintained at a small cost, as there are very few heavy cuts and embankments; and as the tolls are in proportion to the miles travelled—the great length of the road in proportion to the capital invested, will be an advantage in the end.

There is good reason to expect, that when we shall have finished the road as far as we now have it under contract, it will pay a good interest on the investment, and that the time will soon come, when it will be as profitable to its Stockholders as any road in the Southern States.

Preparations are being made for the opening of a large transportation business in the fall. We have now five Locomotive Engines, and expect two more by the first of September, and a sufficient number of Freight and Passenger Cars will be provided, to meet any amount of business that may offer.

I am, sir, very respectfully, your obedient servent,

L. O. Reynolds, *Chief Engineer.*

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ANALYSIS OF SAND STONE.—ON THE CORRECT METHOD OF ASCERTAINING THE RESISTABILITY OF STONE TO FROST, TRANSLATED FROM THE GERMAN OF DR. BUEHNER, PROFESSOR IN THE UNIVERSITY OF VIENNA.

The means of ascertaining the capability of resistance of stone against frost occupied the attention of scientific men at an early period; but, although some recent communications have been made on the subject, they are but reproductions of the experiments of the mineralogist Brard. His system, which is that of subjecting stone to the action of Glauber salt, so as to produce a low temperature, has long been adopted as a universal medium in most countries of Europe, and sanctioned by many high authorities. It is truly observed, however, by Professor Fuchs, in Erdmann's Journal, that

such a mechanical method is of no more certainty than to rasp the stone with the finger nail, or strike it with a hammer, and that the only competent test is to subject it to chemical analysis.

The builders employed on the royal works at Munich have, in the course of their extensive practice, resorted to this process of analysis in preference to the usual method, and the following is an acoount of the experiments of M. Stumb, principal builder in that city:—

On the occasion of repairing the weather side of the tower of the Lady Church, at Munich, he instituted an examination into the sandstone of Waakirchen, in the district of Wiesbach. This sandstone is of a bluish grey colour, equal and fine grain, noways splintery, of moderate hardness, and giving sparks when struck with steel. On a closer inspection, minute specks of mica and quartz may be perceived.

A piece of this stone, weighing 30 5-8 ounces, was laid in distilled water for 24 hours, and on being taken out and weighed, it was found to have increased 6 grains, hardly two per cent., and affording a good proof of its closeness of formation, and small power of absorption.

The water in which the stone had been laid was evaporated to an ounce, and a yellowish residuum obtained, which, on being subjected to reagents, was found to consist of sulphate of lime and sulphate of soda, mixed with organic matter.

A piece of the sandstone was pulverised, and 100 grains of it treated with muriatic acid, and a partial dissolution effected by the development of carbonic acid gas. The remaining acid having been renewed by evaporation, the residuum of quartz sand was washed and cleaned with warm water, and found to weigh 57 grains.

The muriatic residuum was subjected to nitrate of ammonia, whereby alumina was produced, with a portion of oxide of iron. It weighed, on careful trial, 3 1·2 grains.

The solution filtered from the aluminous precipitate was treated with oxalic ammonia to produce deposition of the lime, which was exposed to the fire to convert the oxalate of lime into carbonic acid gas, and by which 24 grains of carbonate of lime was produced. The fluid filtered from this was acted upon by phosphate of natron, and a precipitate of phosphate of ammonia and magnesia appeared; which by heat was reduced to neutral phosphate of magnesia, which was calculated as 13 per cent., of carbonate of magnesia.

The composition of the stone was, consequently,

| | |
|---|---|
| Quartz - - - - - - | 57 |
| Alumina - - - - - - | 3-5 |
| Carbonate of lime - - - - | 24 |
| Carbonate of magnesia - - - | 13 |
| Loss - - - - - - - | 2-5 |
| | 100 |

From these results it was proved that the sandstone of Waakirchen was a good building material, and fully capable of resisting the effects of air and water, as its component parts were not liable to decomposition, and its texture did not admit the introduction of their mechanical force.

It is evident that it is only by such trials that the true qualities of materials are to be ascertained, as mere mechanical action, or a trial of temperature, affords no criterion of the chemical constitution by which injuries of weather are caused.

EXPERIMENTS ON THE POROSITY OF A MASS OF COTTON.

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

*Sir*:—

Perhaps you may consider the following pretty experiment on porosity, worthy of a place in your Journal. Fill a common glass tumbler, or other vessel, completely with some spirituous liquor, so that a few drops more would cause it to overflow. This done, you will find no difficulty in introducing into the tumbler, so filled, *a whole handful of raw cotton.*

This experiment was suggested by the accidental recovery of some wet cotton from a boat which had been sometime sunk in the Tennessee river; it was found by the workmen that after they had squeezed out the water from some cotton, the vessel in which it had been contained, remained nearly as full as before the cotton was removed.

Spirits answer better than water, for trying the experiment, from the rapidity with which they are absorbed by the cotton. Several theories were started by persons who tried the experiment; such as, that the filaments of cotton occupied the vacancies between the globules of water; or that by its capillary action, the cotton subdivided the globules, and caused them to occupy a less space, &c.; to me, however, it appears to be accounted for more satisfactorily, by supposing the fluid to insinuate itself between the filaments of cotton, and thus permit the latter to occupy no more space than is due to their actual solidity. The experiment is certainly a beautiful one.

Very respectfully, yours, &c.,

JOHN C. TRAUTWINE.

*Knoxville, Tennessee, June* 12, 1839.

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OHIO CANALS.—A statement of the amount of Tolls collected on the Ohio and Miami Canals, for the month of June, 1838 and 1839.

| | 1838. | 1839. |
|---|---|---|
| Akron, | 2,445,13 0 | 2,158,46 0 |
| Circleville, | 4,821,58 0 | 3,346,69 0 |
| Chillicothe, | 4,044,74 1 | 6,527,83 0 |
| Cleveland, | 10,878,92 0 | 20,327,20 0 |
| Columbus, | 2,848,59 0 | 2,687,15 0 |
| Cincinnati, | 1,171,03 0 | 3,292,91 0 |
| Dover, | 3,128,22 5 | 4,197,55 0 |
| Dayton, | 474,70 0 | 1,980,64 0 |
| Hamilton, | none. | 117,08 0 |
| Massillon, | 3,512,27 5 | 2,802,34 0 |
| Middletown, | none. | 544,10 0 |
| Newark, | 18,483,26 0 | 10,166,41 0 |
| Portsmouth, | 5,073,00 3 | 4,430,83 5 |
| Piqua, | 10,99 0 | 134,85 0 |
| Roscoe, | 8,032,18 5 | 5,073,95 0 |
| Total, | 64,924,62 9 | 67,836,99 0 |
| | | 64,924,62 9 |
| Making an increase for 1839 of | | 2,912,36 1 |

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SPECIFICATION OF A PATENT GRANTED TO NATHANIEL WORSDELL, OF LIVERPOOL, FOR IMPROVEMENTS IN APPARATUS TO FACILITATE THE CONVEYANCE OF MAIL BAGS, AND OTHER PARCELS, ON RAILWAYS OR ROADS.—*Sealed, January 4th,* 1838.

At present, in taking up or leaving mail bags, or other parcels, conveyed

by railway or railroad carriages, it is necessary to stop the train of carriages or so much to reduce the speed of the train, that the person at the station may hand up the bags, and that the guard may deposit the bag, or bags, to be left, on the ground, or with a person placed to receive them. And according to both these means, much delay necessarially takes place in the conveyance of mail bags, as well as loss of time to the whole train. And further, when the speed is only reduced, [in place of stopping the whole train of carriages] the bags are liable to be missed by the guard, and such has often been the case, and the bags have fallen to the ground; and in addition to the delay caused by the stopping of the train, and backing the same to the spot where the bag had been left, or otherwise waiting until the same is brought to the train, the bag has, in some instances, been found to be materially injured, and cut, by the wheels passing over it. And from this reason, in case the stations were numerous along a line of railway, which it is very desirable should be the case, in order to give the utmost extent of quick communication, the time lost, even in diminishing speed to take up and put down letter bags, and again to get up the speed of the train, when compared with the whole running time of the train of carriages between two places, would be found to be a most serious loss of time, and will be found to offer almost a barrier to numerous stations being had on a line of railway, or railroad, for mail bags and for parcels. Now, my invention consists in applying mechanical means to railways, or railroads, and the carriages which run thereon, whereby mail bags may be taken and left at any determined places, or stations, with the greatest facility, without stopping or retarding the motion or speed of the train of carriages, and by such means the number of places for taking and leaving mail bags may be increased very materially, and the general system of conveyance of mail bags facilitated. And although I have here spoken of mail bags, I mean it also to apply to bags containing parcels, for it is better to put small parcels in bags.

The principle of action of the apparatus applied is such, that a bag containing letters, or parcels, being held in such a position as to be in the way of suitable means or instruments for taking the bag, and on the other hand, where it is desirable to leave bags, there is connected with a carriage of the train, suitable apparatus or instruments to support the bag in a position to be intercepted by apparatus or instruments for taking the bag so placed. Now it will be evident that the apparatus in both cases may be varied as to its particular action or formation, to produce the desired effect, and yet remain in substance the same. I do not, therefore, confine my invention to the instruments here shown, though I believe they are the most simple which can be employed, and the best for the purpose. In my arrangement, a bar is applied at the back of a railway carriage; this bar is capable of sliding to and from the carriage in staples, affixed to the back of the carriage, usually that carriage of a train of railway or railroad carriages called the mail, when the same is intended for mail bags; but it will be evident that the apparatus may be applied to other of the carriages, when intended for the delivery of parcels, and the apparatus for parcels may be separate from the apparatus for mails. A set screw, applied by the guard, [when he has slided the bar to its position] fixes the bar for the time, till it has taken up or left the bags held thereby. A prong projects from the bar, at right angles thereto, and is curved upwards, in order, when a mail bag has been taken by it, that the same may not fly off by any motion or swing, which may take place by the same being put suddenly into motion with the train of carriages. At each station, or place where it is desired to take or leave mail bags, there is to be an apparatus suitable for holding the bags, to be

taken by the train of carriages when passing; and if bags are to be left at the same place, then there is to be fitted up suitable apparatus for receiving the bags which are carried by the bar, on the projecting prongs. The apparatus applied to the railway, or railroads, at the determined stations, or places, is similar to that applied to the railway or railroad carriage, and the apparatus is sustained by a post, or upright, on which may be placed a lamp.

Having thus explained the nature of the apparatus which I prefer for carrying out my invention, and which I have found fully to answer for taking and leaving mail bags and parcels when travelling at high speeds, I will describe the manner of using the same. The guard places the cord, strap, or chain, on to the prongs of the bar, or a number of bags may be strung on to a strap, cord, or chain, or other convenient means or instrument, and together securely placed on the prongs; he then slides out the bar, and fastens it by the screw; it will consequently follow, that when the train of carriages passes the station or place where there is a suitable apparatus.the bag or bags, on the bar will be taken by a prong, or other suitable instrument; and if it be desired that there should be a bag, or bags, taken by the train, as well as left at a station, then such bag, or bags, are to be supported by suitable means, such as the prongs, the post, and the prong of the bar, will take such bag, or bags; and it only remains for me to remark, that I lay no claim to any of the parts separately, nor to their use, for any other purpose than for carrying out my invention, which I declare to consist of the application of mechanical means, such as herein explained, to railways, or railroads, and carriages traveling thereon, for taking and leaving mail bags, and parcels, whereby much time will be saved, and certainty of action obtained, and whereby the conveyance of mail bags, and parcels, will be materially facilitated, as above described.—*Rep. Pat. Inv.*

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## PROCEEDINGS OF SCIENTIFIC SOCIETIES—INSTITUTION OF CIVIL ENGINEERS—REPORT OF PAPERS READ AND PROCEEDINGS, SESSION 1838.

### Thames Tunnel.

Mr. Brunel stated that they were at present* more inconvenienced by fire than by water. Some of the gases which issue forth, ignite very rapidly; and the reports from Guy's Hospital stated some of the men to be so injured by breathing these gases, that small hopes were entertained of their recovery. The explosions are frequent, and put out the candles of the workmen; but the largeness of the space prevents their being dangerous. The thickness of made ground above them is about 18 feet. He conceives that these deleterious gases issue from the mud of the river; they proceed from a corner at the top. They had used chloride of lime; but without any great success; there appeared no remedy for the inconvenience. The breathing the gas produces sickness.

Explosion of Steam Boilers.—A communication was read from Mr. Timperley, of Hull, on the explosion of the boiler of the Union steam-packet at that place last summer. This was attributed to the water in the boiler having become so far reduced as to lay bare the tops of the flues, which would probably be heated to a very high temperature. Water coming in contact with them in this state, on a slight lateral motion of the vessel, steam of sufficient intensity to produce the effects described might be produced.

Mr. Macneill stated that the boiler plates had in the above instance

*May 15.

been rent across like a sheet of paper. There was not a single rivet broken.

A long discussion took place on the causes to which these extraordinary cases could be referred: the violence of the explosion on bursting, appearing greater than could be referred simply to the pressure of the steam. If the water were supposed to be decomposed by contact with the hot plates, some of the oxygen would be absorbed by the metal, and the proportion requisite for an explosive mixture destroyed. But there were great difficulties in conceiving the decomposition of water by the plates of a boiler. The commission of the Franklin Institute concluded this to be impossible.*

It appeared then, that there were grounds for doubting the fact of the presence of oxygen, such as would cause an explosion. And it seemed almost unnecessary to resort to any such explanation, as the sudden generation of steam of high elasticity would produce a pressure sufficient to blow out or rend the boiler in the weakest part, before the pressure could be transmitted through the steam to the safety valve. The transmission of pressure through an elastic fluid requires time, but the action on the solid is instantaneous.

It was suggested whether a large portion of hot surface might not become suddenly exposed by the cracking off of the incrustation on the sides of the boiler. The metal expands more rapidly than the incrustation; portions of the latter may crack off and expose a large extent of hot surface to the steam and water; a sudden increase in the elastic force of the steam would necessarily ensue. The incrustation is itself a bad conductor of heat.

Mr. Field, in reply to a question respecting the rapid decay of the bottoms of copper boilers, stated, that copper is very rapidly injured by repeated heatings, and will not long bear high degrees of temperature.

Mr. Cubitt stated that he had not known of any case of explosion of a boiler containing plenty of water. With respect to a recent accident in America, which had taken place soon after the boat had started, he thought that a boiler was more likely to be short of water at starting than at any other time, for the steam will probably have been blowing off for some time, and the men have neglected to supply the boiler; whereas after the vessel has started, the pumps worked by the engine supply the boiler. He should think that a boiler is more likely to be short of water before or just after starting, than at any other time.

Mr. Field stated that the vessel had stopped, and the explosion took place while taking up a passenger; the safety valve had been held down. In all these cases of explosion the difficulty which he experienced was, how to account for the pressure being suddenly increased by the amount which must be supposed. It did not appear to him sufficient to suppose that water flowed over hot flues. If the whole of the top of the fire-place were red hot, this could not produce the effect. The steam boilers in America are generally of a form ill adapted to resist pressure.

Mr. Buddle stated that the only clearly ascertained fact seemed to be, that these explosions took place when the boilers are dry. He had a case of twin boilers, standing side by side; the dry one exploded; no cause could possibly be assigned but that it was dry. The steam communication betwixt the boilers was free, by a pipe *eight* inches diameter. It was not a collapse, but the boiler was torn into a thousand pieces. There are two

* See Report of Franklin Institute on the Explosion of Steam Boilers.

distinct cases; the one a rent or bursting, the other an explosion, in which the parts are thrown to a considerable distance.

Mr. Cubitt called attention to the remarkable case mentioned by Mr. Buddle, of two boilers connected together by a steam pipe of eight inches diameter, the communication free betwixt them, but one short of water; the other having its proper quantity of water. The dry boiler blew up with a great explosion, the other remaining uninjured. The steam was blowing off at the time. With respect to the nature of the report, Mr. Buddle stated that he had not himself heard it, but it was represented as sudden and short; any representation of this nature cannot be depended on, as two persons situated in different positions will give very different accounts. This had occurred to his knowledge on the explosion of a coal mine. He was close by, and thrown down; the report was smart like that of a six-pounder; at two miles off, it was like a peel of thunder, shaking the houses and throwing down the furniture. One peculiar feauture in the explosion of steam boilers is the rending and crumpling up of the boiler plates. The plates are rent and twisted as if of paper.

History and Construction of Westminster Bridge, accompanied with detailed Drawings.—By F. Whishaw, M. Inst. C. E. This account of Westminster Bridge has been extracted from the very voluminous documents in the Westminster Bridge Office, access to which was given to the author of this paper by the kindness of Mr. Swinburne, the resident engineer to the bridge.

The first act was passed in 1736, and empowered certain commissioners to raise moneys by lottery. Three sites were pitched upon; the Horse-ferry, over against the Palace Yard, and over against the Woolstaple, which latter was finally fixed on. The scheme was violently opposed by the city of London and the Thames watermen. The commissioners selected a very curious and well-designed wooden superstructure, by James King; but having determined that the bridge should be of stone, they accepted a proposal from Mr. Labelye to found one pier by means of caissons, and which he had offered to build at his own expense.

This bridge, so lasting a monument to the genius of Labelye, consists of fifteen semicircular arches, decreasing regularly in span by 4 feet from the centre, which measures 76 feet, to the sixth arch on each side, which is 52 feet in span; all the arches spring from the line of low water of 1736. The whole distance between the abutments is 1068 feet, with 870 feet clear waterway, and 198 feet solid. A peculiar feature in this bridge is, that the spandrels are formed of radiated Purbeck blocks, with occasional bond stones, and the interior filled with ballast and rubbish.

The design of Mr. Labelye was the only one for laying the foundations of the piers under water, and the application of caissons for this purpose then first took place. The construction of these caissons and method of founding the piers by means thereof are fully described and illustrated. The piles were driven by an engine invented by Mr. Valoue, a watchmaker; it was erected on a platform, fixed on the top of a barge, and worked by three horses walking round and turning an upright shaft, on which was fixed a large cog-wheel and a drum, on which the rope was wound, and passing by pulleys to the top of the guide frames was connected with a follower furnished with tongs, as in the common pile engine. The number of strokes in an hour was about 150, at an elevation of 9 feet; the weight of the ram 1700lbs. The piles were generally cut off; the time occupied in cutting off a pile about 15 inches square and 10 feet under water being not more than a minute and a half. The construction of the abutments

and of the arches is fully described, and the quantity of stone employed in the middle 76 feet arch, and the two adjoining 72 feet, is stated; the expense of these three arches was 24,074*l.*

The centres employed were on the principle of the diagonal truss; for the five middle arches three rows of piles were driven on each side to support the centres, and for the other arches only two rows. Each centre consisted of five ribs of fir timber, resting on transverse and longitudinal oaken plates. The five centres used on the Westminster side were afterwards used for the corresponding arches on the Surrey side; the striking of the centres was first performed by means of circular wedges of a peculiar construction; this mode, however, from its expense, was superseded by straight wedges.

A most interesting portion of the history, is that which relates to the 15 feet sunken pier. There was no piling under the caisson bottoms, and the removal of gravel of the bed of the river very near the pier in question occasioned consequently a sinking. The progress and nature of the sinking are accurately detailed. The south point had settled 14 inches and the north point 13 inches; and the sinking still going on, it was determined to remove the superstructure above the sunken pier and damaged arches; the sinking still continued, but at last appeared to stop, and the whole amount was found to be 3 feet 4 inches at the north-west angle, and 2 feet 7 inches at the south-east angle, of the pier. Centres were erected under the two damaged arches, the adoption of which plan was recommended to the commissioners in the following words:—"If the pier should settle much more, it is not in the power of any mortal agent or agents to hinder the arches from following it, as long as it is possible; and therefore, in that case, the two arches instead of parting asunder, and their materials falling into the river, and not to be taken up without a great expense of time and money, will be received and their materials supported and secured, in order to their being regularly unbuilt." The pier, however, lightened as above described, did not continue to sink, and the weight over the piers was considerably reduced by introducing segment arches over the 15 feet pier, and half arches over the adjoining piers, leaving a considerable void space beneath each.

Labeyle presented to the commissioners several reports on the open joints, on the sunken pier, on the Surrey New Road, and on the completion of the works. These are most interesting, serving, as they do, to exhibit the state of engineering at that time in the country.

A detailed account is also given of the ingenious wooden superstructure designed by Mr. James King, and of Mr. Batty Langley's design for a wooden bridge at the Horse-ferry. The author has also collected, at immense pains, the prices of materials and of labor, as paid in the erection of Westminster Bridge; he has also compiled a journal of works from the commencement of the undertaking to the time the bridge was opened. These most interesting and instructive documents are collected from the voluminous records deposited in the Bridge Office.

The paper is accompanied by an atlas of eleven drawings, showing the site and all the details of the bridge, with facsimile signatures of Charles Labelye the engineer, and Messrs. Jelfe and Tufnell the contractors.

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THE THAMES TUNNEL.—COPY OF MR. WALKER'S REPORT TO THE TREASURY, ON THE WORKS AT THE THAMES TUNNEL.

In consequence of several propositions made to the Lords commissioners of her Majesty's treasury, for further means for continuing and facilitating the work, they directed James Walker, President of the Institution of Civil

Engineers, to take into consideration the various papers relative to the late irruption of the river, with the special reports from Mr. Brunel, of the works proposed to be carried on at the tunnel, and to report to the treasury his views and opinions on the eligibility and means of prosecuting the work.

"I gave the subject, [says the reporter], my immediate attention, and was preparing a report thereon, when on the 2nd November, another [the fourth] irruption of the Thames took place, and on the 6th, when I visited the works of the tunnel, Mr. Brunel, the engineer, and Mr. Charlier, the secretary, requested a postponement of my report for a short time, until they should complete an expected arrangement with the navigation committee of the river Thames from which they expected increased facility and security. This request I communicated to Mr. Baring, by letter, on the 9th November.

I have since received Mr. Spearman's letter of the 2nd December, transmitting to me, by command of the lords of the treasury, a copy of a letter from the secretary to the Thames Tunnel Company, dated 15th November, together with a report of Mr. Brunel on the present state of the tunnel, and the best mode of proceeding, and also a plan of the works, with a request that I would communicate to their lordships my opinion upon the several points referred to in the papers, previous to their determining on the proposals and recommendations of the company.

Since receiving the above instructions, Mr. Spearman has stated to me the desire to be, that every point, particularly as respects cost or estimate, which I consider of importance in the general question of the tunnel, should be included in my report, so as to bring the whole fairly under the consideration of their lordships.

That Mr. Brunel's different reports in which the same recommendations are repeated, may be brought to their lordships' recollection, I shall give a short abstract of the main points in the order of date.

In his report of 2nd May 1837, Mr. Brunel ascribes the difficulties which had retarded the progress of the tunnel for the last five months to the excessive rains of the preceeding autumn, liquifying the ground between the ceiling of the shield and the river, and causing it to run into the works; he states that this has been augmented by his being deprived of the pumping well and drain from Wapping, which is stated to have been originally intended, and to have been considered the most efficient means of drainage, particularly as the dip of the strata is to that side, and that before any satisfactory progress can be calculated on, the proposed pumping well, with a drain or drift-way, should be made, but that a preferable plan would be to sink the fifty-feet shaft for the foot passengers' descent, which would, he considers, be a better means of drainage, and would give employment to the workmen when not in the shield. The fact of the pumping at the entrance of the London Docks having dried the wells in that neighborhood, is adduced as a proof that a pumping-engine on the Middlesex side would diminish the land-springs in the tunnel.

(To be continued.)

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The Philadelphia Gazette of the 7th says:—" The receipts of the Philadelphia, Wilmington and Baltimore Railroad Company, for the last quarter, including the months of June, July and August, amounted to upwards of $127,000, and those of the Newcastle line to Baltimore, to upwards of $58,000, making the receipts of the two companies more than $185,000.

This has not been a travelling season certainly, and we may therefore confidently calculate on an increased income in the corresponding quarter of next year.—*United States Gazette.*

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

No. 4. Vol. III. New Series. | AUGUST 15, 1839. | Whole No. 340. Vol. IX.

## ELECTRO MAGNETISM AS A MOTIVE POWER.

The great notoriety to which this subject has attained, demands that it should receive from scientific men, more attention than hitherto. Since the first successful experiments in Electro Magnetic motion, innumerable attempts have been made to produce engines acting under this agent—the plans of these have been as various as their sizes, which are from that of a mere philosophical toy, up to one said to be of one or two horse power. The various merits of these, we by no means intend to discuss, because in the first place, the elements of a proper comparison are not given, and not to be found, and in the second place, the institution of such a comparison would draw upon us the full power of the *batteries* of the various patentees and their partizans, an encounter which, whatever might be our disposition, we have no time for just now. Perhaps some day or other, we may get up a *battery* of our own, then, of course, we cannot decline the contest.

Our object at present is, rather to point out in general terms, what has been accomplished and what may be done towards the perfection of this kind of machinery, with reference to the probable extent of power attainable by such perfection.

The various models and engines hitherto constructed, have been nearly all upon the principle of producing a rotary motion by the alternate attraction and repulsion of moveable electro magnets with changeable poles, by fixed electro magnets with poles unchanged. More recently, this form has been exchanged for one in which revolving soft iron armatures are successively attracted by fixed electro magnets, without change of poles and through which the current is passed just before coming to the iron to be attracted, and ceases when it is reached. Another variation is, in the alternate attraction of armatures on each end of a beam, by electro magnets through which the current is alternately passed—producing a reciprocating, instead of a rotary motion.

The batteries used for these engines or models, with few exceptions have been of the common form of concentric cylinders of zinc and copper alternately placed, and excited by a dilute sulphuric acid, sulphuric and nitric acid, or a solution of sulphate of copper. The necessity of occasionally exposing this battery to the air, induced us to suggest to the inventor of the first electro magnectic engine we ever saw, the plan of forming the zinc and copper into circular plates mounted upon an axis, upon which they might be turned by hand, or better by the machine itself, and with rather less than a semicircle immersed, a constant renewal might be effected. This plan we recently saw put into operation, but of the advantage gained by it, no estimate appears to have been made. A patent for a similar battery has, we believe, been taken out. Another modification of this would be, to pass the axis through the system of concentric cylinders generally in use, placed horizontally,

Of the relative power of the various engines already constructed, nothing certain can be said. From inspection, it would appear that while some have been built with the greatest care in the mechanical arrangement, others appear to have been put together in the most inappropriate manner, not only applying the power injudiciously but losing much of the power so applied, in the enormous friction of complicated parts. As to the knowledge of the science of electro magnetism displayed in these various constructions, while in some, we have to admire its amount and application, in others we in vain look for any thing of the kind. Even some persons who have been rather successful in their first attempts have retrograded in their succeeding ones. The reason of this, apart from the general ignorance of the science is the want of a correct knowledge of the power already obtained. The simple method of ascertaining this by the time through which a given weight may be raised through a given space; has seldom if ever been tried, or if it has been tried, its results have not been made known. Now all this is but working in the dark—few machines are more easily adapted to this simple test, and why should we not have the benefit of its application? How can an inventor know with certainty, whether he is advancing or not in the form of this machine, unless he knows how much each machine can do? Simple as this mode of trial is, it has not been adopted as the test of power, as it most undoubtedly should be, and *must* be, to satisfy the judicious and prudent. This means of estimating the power, and the simple process of ascertaining the loss in weight of the battery,* and consequently the cost, furnishes us with the value of the power in each machine. For example, a machine is ascertained to raise through one foot, in one minute 33,000 pounds or a weight equal to that raised by one horse power. The battery is to be carefully washed, dried and weighed before and after the experiment, the loss indicates the quantity of zinc consumed, and this being a correct representation of the *relative* cost in each machine, we can at once estimate their comparative advanta-

* In this experiment, dilute sulphuric acid should be employed.

ges. When it is desired to ascertain the absolute expense, we add two-thirds to the weight of the zinc for the weight of the commercial sulphuric acid, and then can readily calculate the expense of the materials.

Provided with this means of ascertaining the precise value of each form of machine, we would propose the investigation of the capabilities for improvement in the following manner. All other things remaining the same, increase the size of the battery until the power gained is a maximum. The size of the battery remaining the same, vary the quantity of acid in the charge until the greatest effect is produced. The battery and its charge being retained in the most advantageous condition, increase the *size of the conductors.* We are inclined to think that a few trials would lead to this result; that the greatest power, at least cost, would be obtained by using very large batteries, excited by a slightly acidulated liquid or even by ordinary sea water, and connected to the engine by conductors of large size, or diameter. We have had occasion to remark the benefit of large conductors, in using a model moved by the influence of the earth's magnetism. It had been found impossible to cause the machine (which was not very skilfully made) to move by any increase of acid in the exciting fluid, when having applied unusually large conductors the motion immediately commenced, though the battery was not highly excited--a result precisely such as might have been predicted from a knowledge of the principles of the science.

It may be objected to these and the other trials which we may suggest, that they are tedious and costly. They certainly are somewhat so—yet, unless anticipated by a higher degree of knowledge than has generally been applied to the construction of this machine, they are absolutely necessary to its progress.

It will be found that a certain size of coating wire will give a maximum for each size of magnet and of battery. It is not improbable that a change in the size of the armature may likewise be attended by an increase in power.

We have then, the power of increasing the effect of the machine in five different ways without in the slightest degree altering its principle of construction or even its form. A gain of at least 50 per cent, might in this manner be obtained, over the present power, in most forms of electro magnetic engine.

It would in the next place, be desirable to ascertain the effect of an increased number of armatures and of magnets, and also, the most advantageous disposition of them. It is in this, that the great difficulty of increasing the power of the machine lies, and here the greatest skill is necessary in the arrangement of the parts. In fact, nearly every successful construction has been of that kind which operating by two magnets, may be called the simple electro magnetic engine, in contradistinction to that form which consisting of more impelling magnets, might be called the compound electro magnetic engine. It remains to be proved whether the first or last of these forms is most capable of an increase of power, but before such com-

parison can be fairly instituted, certain laws of magnetism hitherto disregarded, must be attended to in the construction of compound electro magnetic engines. The greater or smaller diameter of the wheel having an important bearing upon the power and velocity, requires also to be experimented upon, in order to obtain a fair comparison of the two forms of construction.

In the construction of the battery, much yet remains to be done. Scientific men have hitherto agreed to a few general principles only, and every day we notice some new galvanic battery, which has its peculiar advantages. It has long been determined that a much larger surface of copper than of zinc is necessary, but the exact proportion is not so certain. The difficulty of determining this, depends upon the greater distance between the metals when the surface of one is much greater than that of the other, accordingly the ratio is variously estimated from 2 : 1, to 16 : 1. By simply cutting the copper into strips and placing them with their edges opposed to the zinc plates, the maximum of surface of copper might undoubtedly be obtained without any sacrifice in the distance of the plates.

Though less economical in point of weight of metal, yet from the facility of construction, wires might be used instead of strips of copper. All preceeding experiments have determined that a considerable gain would result from some such form of battery, but although in the electro magnetic engine every thing depends upon the economical use of this part of the machine. Its importance appears to have been entirely overlooked.

(To be continued.)

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## THE THAMES TUNNEL.—COPY OF MR. WALKER'S REPORT TO THE TREASURY, ON THE WORKS AT THE THAMES TUNNEL.

(Continued from page 96.)

Mr. Brunel estimates the expense of the shaft, including the steam-engine, pumps, &c. at 6,844*l.*, and the pumping well alone, at 2,690*l.*, independent of the drift-way or drain, which he calculates at 4,310*l.*, making together 7,000*l.*, which sum he presumes would be saved by forming the shaft, rather than the well, at the present time, exclusive of keeping the workmen and establishment employed, and thereby reducing the amount which is now charged to the tunnel account. He also mentions the impregnation of the water with sulphureted hydrogen, which has proved very injurious to the health of the workmen, as another reason for making the drift-way, as it would be the most effectual means of drawing it off. The report states, that "the fact of sixteen feet of the tunnel having been completed under the described difficulties, is a proof that it can be accomplished, though, owing to the disadvantages, at an enormous price, and that it never could be intended in the conditions of the treasury that he should be deprived of the means of completing the work at the estimated cost."

Mr. Brunel's report, dated 9th August, 1837, recapitulates the substance of his previous report, and adduces the successful result of pumping-engines and drift-ways erected for the purpose of taking off the land-springs that impeded the formation of the Kilsby tunnel in the line of the Burmingham railway, as a proof of the good effect that would be felt in the works of the Thames tunnel by a pumping-engine on the Middlesex side. He states also, as an argument for the works he proposed in his former report, the

importance of giving the disturbed and artificial ground time to consolidate, and now proposes, on the completion of the Middlesex shaft, to commence the tunnel on that side also, with a view to greater expedition and economy, and to keep the full complement of men more regularly employed by having the two ends to work at. This, it is stated, would reduce the cost of conveying the men, materials, and excavation to the shaft on the Surrey side. In this report Mr. Brunel further states, that as soon as the plan he has proposed is in satisfactory operation, the formation of the carriage roads might be commenced simultaneously with the tunnel, and that by the various means he now proposes, a saving might be effected in the time of four and a half years, which, in my report of April 1837, I considered requisite for the completion of the tunnel and approaches, and that, consequently, there would be an earlier receipt of toll and a saving of current expenses and machinery to the amount of 15,000*l.*, by the works being completed one year and a quarter within the time I had calculated. Various accounts and calculations in proof of his several positions are appended to this report of Mr. Brunel, and an estimate that, to carry on the works as he recommends, the sum of 94,000*l.* will be required during one year from August 1837.

The lords commissioners of Her Majesty's treasury having refused their assent to the tunnel being begun on the Middlesex side, Mr. Brunel in his report, dated 7th September, 1837, repeats the other recommendations of his former reports.

The last report of Mr. Brunel that is referred to me, is dated 15th November, 1837, the fourth irruption of the Thames having taken place on the 2nd of that month. In this report he considers the third irruption [that of the 23d of August] as not having been unfavorable in one point of view as it would enable substantial ground to be substituted for the loose silth that had worked into the tunnel by the irruption; in proof of which he states that the work done before the third irruption cost 9000*l.* per lineal foot, while what was done between the third and fourth irruptions cost only 630*l.* The former recommendations and arguments are repeated, and in addition it is now stated that the fourth or last irruption was caused in a great degree by the part of the tunnel then in progress being under the portion of the river chiefly used for navigation, and that the depth being small, the artificial bed of the river, or roof of the tunnel, was liable to be disturbed by passing vessels. This, Mr. Brunel now proposes to remedy, by deepening a part of the river where the tunnel is formed, moving some of the ships in the tiers near the tunnel from the northern to the southern side of the river, according to a plan which accompanies his report, throwing the space which is required to be kept clear for the navigation from the north side towards the middle of the river, over where the tunnel is formed, so as to leave the space which is in advance of the works free for tunnelling operations, and then substituting a thicker roof of clay and gravel raised above the present level, to which, from the navigation not being then over that part, there would not be the same objection as at present. The thicker roof Mr. Brunel proposes to make 100 feet in length, or in advance of the shield, and 100 feet on each side of it. He calculates on a great saving in the end from this artificial covering, which he estimates at 1,800*l.*, and ascribes much of the late trouble and expense to the passing ships, and the want of a sufficient thickness in his roof, which the navigation prevented his having.

The reports are drawn up in great detail, and the above abstract is to be considered not as a substitute for them, but only as bringing the leading

points to recollection in one view, without the repetition which the reports themselves, being of different dates, naturally contain.

It is now my duty to state my opinion; which is, to recommend Mr. Brunel's proposal to be adopted, as the most economical and creditable way of executing the works, if it be the determination that the Thames Tunnel [a work which for many years has attracted much of the public attention in this, and still more in other countries, and upon which upwards of 80,000*l.* of public money has been advanced,] shall be completed, without making cost an element in the question. I would then even advise more effectual works in front of the shield than Mr. Brunel's description and estimate of 1,800*l.* contemplates; for if the work is to be considered a national or government work, a repetition of the danger, the late irruptions, and the enormous expense of the work, would be discreditable, and, as it may be, it ought to be prevented. In addition to Mr. Brunel's proposals I would recommend, after the removal of the clay that has lately been thrown in, and a portion of the silth, that two rows of close whole timber piles should be driven between where the ground begins to rise and the present shield, one row on each side of the line of tunnel, with space between sufficient for the shield to travel, and to as great a depth as they can be conveniently driven, the heads being level with low water. These, with a return of shorter piles at the end, would form a dam against the silth. The piles being driven, I would continue the dredging of the silth in the space enclosed by the piles, and then fill up with clay, gravel, &c., as at present, to a sufficient height, and afterwards give the mass time for consolidation before attempting to advance the shield, which, in my report to the commissioners for the loan of exchequer bills, I stated to be an essential element for success in the undertaking. In the progress he has made through very bad strata, Mr. Brunel has fully tried and proved the great power of his excellent shield; but the strata, rendered worse by the irruptions and the cause assigned by Mr. Brunel, are now too bad for even the shield to overcome. By the substitution of good artificial soil to work through, and keeping the silth, or sand, back by the piles, there would be much less difficulty or danger; and with proper precautions, my decided opinion is, that the tunnel may be completed notwithstanding the late irruptions, and with comparatively little difficulty or risk.

Here the question naturally presents itself, at what cost? and to answer it with the probability of accuracy, is still very difficult.

| | |
|---|---|
| The amount of the company's capital expended previous to any advance of public money was 180,000*l.*. | |
| On the 27th February, 1837, when - - - - - - | 64,600 |
| received from the commissioners for the loan of exchequer bills had been expended, I estimated the addition then required to complete, at - - - - - - - - - - - - - | 310,000 |
| Making, exclusive of the company's capital - - - - | $374,600 |

Between the 27th February and the 2nd November, 19,300*l.* have been expended, making 83,900*l.* of public money expended to the 2nd November, but the quantity of work done with the above 19,300*l.* is only 19 feet 6 inches, making, [inclusive of 1,400*l.* for pumping, excavating, and claying, after the third irruption,] nearly 1,000*l.* per foot, which very much exceeds all previous estimates, and proves what I stated in evidence before the select committee of the house of commons, that no prudent man would committ himself to the accuracy of an estimate of this work, while it shows also the impolicy of attempting to drive on the shield

through the present bad soil without a sufficient covering, and time for consolidation.

In the present situation I consider that the sum of 150,000*l.* should be taken as the estimate for completing the tunneling; and that the shafts and other works remaining to be done, together with the purchases, should not be estimated under 200,000*l.*, making, with the 84,000*l.* of public money already expended, and the company's capital previously expended, a total of 614,000*l.* for the estimate of the work, or upwards of triple the original estimate, and this is allowing but a moderate sum for contingencies, which have heretofore been very heavy.

I have estimated the great descents at double Mr. Brunel's estimate. and yet I have, from the nature of the work, as much doubt as to the sufficiency of that sum as of any other item in my estimate.

If, however, in place of determining to complete the tunnel without reference to cost, which the foregoing observations suppose, the lords of the treasury resolve, as heretofore, to confine their operations to the advance of the tunnel, so as to remove any doubt of its getting through, before they sanction a further heavy outlay, then, although I agree with Mr. Brunel that the pumping well or the shaft, with the drift-way, or drain, would lessen the springs, I do not by any means think them so essential to the progress of the work as to agree in recommending their being proceeded in at present. Up to the time of the second irruption, in January 1828, the works were under the uncontrolled management of the directors and engineers, and during that period nothing had been done on the Middlesex side with a view of draining the water from the tunneling, although it had then advanced to the middle of the river, only 155 feet having been done since, but in the report of 1831, the drift-way or adit is proposed and estimated, with the pumping well, at 6,000*l.* Mr. Brunel informs me that the drainage in the tunnel is now very small, and the short time in which the water after irruptions has been taken out, proves that the present pumping engine is fully equal to the work.

More rain, by two inches, fell during the last six months of 1836 than of 1835*, an increase, but not such as to cause a very important difference in the workings, which I ascribe almost entirely to the ground towards the Middlesex side being of a looser and more sandy and silthy nature than towards the south side; this, it has always been said by the Trinity officers and others acquainted with that part of the river, would be found to be the case; so that, although the spring water has been an evil and an hindrance, the Thames water has been another and probably a greater, and is the present enemy, which makes the cases of the London Dock or the Kilsby Tunnel parallel to a certain extent only. It is not in preventing the communication with the spring, but with the river water, that the artificial roof of clay, &c., has been useful.

I agree that the air for respiration would be improved by the drift way, and probably the present air-pump, which is worked by the steam engine, rendered unnecessary; but this pump, ingenious as all Mr. Brunel's applications are, appears to completely answer the purpose, and would probably be found quite as effectual in abstracting the sulphureted hydrogen, as a drift-way at the bottom would be.

I cannot agree as to the saving of expense by the shorter distance to the Middlesex shaft; the difference of distance in the present situation of the shield would be only seventy yards, and as an excellent railway is laid, and machinery attached for working it by the steam engine, I am sure that the

* The quantity of rain that fell in the last six months of 1835 (as kept at the Royal Society's rooms) was 10 1-2 inches, and in the corresponding period of 1836 it was 12 1-2 inches. In the same period of 1834, a very dry year, it was only six inches.

conveyance of the excavated soil along the bottom of the tunnel to the low ground on the Surrey side must be at least as cheap as to the Middlesex side, where the ground is chiefly covered with buildings, and does not require to be raised, and that, as a passage to and from their work, the workmen would generally prefer the spacious lighted tunnel to a drift-way, until the difference of distance is much greater than at present.

That the well, or shaft, on the Middlesex side would give employment to the miners and other workmen when they cannot be employed in the shield and thus lessen the amount now charged to the tunnel, I entirely agree; but my opinion at the same time is, that they may be fully employed in securing the ground in advance of the shield, according to Mr. Brunel's plan, or with the additional piling, such as I have suggested. It appears to me that sinking the shaft, driving a drift-way, making a new shield, and proceeding from the Middlesex side, would amount to a committal to go through with the undertaking, and ought not to be begun until that, as a previous question, has been determined.

In stating this, I am in some measure influenced by the opinion that Mr. Brunel's estimate for the works on the Middlesex side is too low. He estimates the pumping well and drift way at 7,000*l*., and the shaft engine and pumps at 6,844*l*., and gives a decided preference to the shaft. Now the shaft on the Surrey side is stated in the account to have cost 20,000*l*., and evidently the drift way, 4,310*l*., should have been added to the shaft, as to the well plan. The Middlesex shaft may, and probably will, be less expensive than the Surrey one was; I think it unsafe to trust calculation against experience, so far as to take one-third of the actual of the Surrey, as the estimate for the Middlesex, shaft.

Of the propriety and importance of changing the channel for the passage of vessels, from the part of the river in front of the shield which has yet to be tunneled through, over to the part which is tunneled, and forming a body of compact gravel and clay in front of the shield, in the way Mr. Brunel proposes, to a greater thickness than is now compatible with navigation, there can be no question; and I am glad to learn, by a letter received from Mr. Charlier, that the Navigation Committee have agreed to the proposal, and as Mr. Brunel considers that this will remove much of the cause of the late irruption, by enabling him to have a better covering of clay, and preventing vessels grounding upon the artificial bed, and estimates the necessary work at only 1,800*l*., I have no hesitation in recommending to the lords of the treasury to sanction it, even with the addition I have proposed, should Mr. Brunel be disposed to adopt it. I think the expense of the piling and clay may be taken at about 10,000*l*., and I feel assured that, if the completing of the tunneling be the object, this outlay will be more effectual, and much less in amount, than proceeding with the works on the Middlesex side. From the length of the river proposed to be covered with clay, if done according to Mr. Brunel's plan, being three times greater than with piling suggested by me, I think the difference of expense of the two plans would be small.

Having now given my opinion on the various points that have been referred to me, I would beg to add that, as the Thames Tunnel is Mr. Brunel's work as respects design and responsibility, any measure that may be proposed for executing the work should, in my judgment, have his approval. If that approval is refused, unless the lords of the treasury will consent to works which exceed the amount they have yet thought proper to agree to, almost any course would be better than letting the complaint be repeated, "that the engineer has been deprived of the proper means of completing the work at the estimated cost." (Signed) JAMES WALKER.

*December* 1837. *Rep. Pat. Inv.*

THE ORIGIN AND USE OF THE STEAM DREDGING MACHINE.—COMMUNICATED BY THOMAS HUGHES, ESQ., CIVIL ENGINEER.

The honor of having first applied steam power to the purposes of dredging has been assigned to various engineers at different times, but it will be found on examination that the greater part of those who have hitherto laid claim to be considered the contrivers of this great addition to the resources of the engineer, have no other foundation for their claims than that of having at periods not long subsequent to the erection of the first steam dredging machine, constructed engines on the same principle.

From the evidence of living witnesses, who are no other than the very men who first worked the dredging machine by steam power, as well as from documents in my possession, I can prove beyond the possibility of doubt, that the first steam dredging machine ever used was constructed by my own father, the late John Hughes, in the execution of several contracts which he undertook for the Corporation of the Trinity House.

The following extracts, from a report by my late father, details the necessity which gave rise to the introduction of this new power, and goes on to show the difficulties he met with in the practical application, and how at length they were all overcome by the production of a dredging engine, which may almost be denominated perfect, when we consider the trifling value and importance which can be attached to any improvements made up to the present time.

When the docks at Blackwell were being formed for the East India Dock Company, it was found necessary to deepen the bed of the river Thames at the moorings opposite the dock gates. With this view the Corporation of the Trinity House were employed for nearly two years, at the expense of the Port of London Committee; but at the end of that period they abandoned their pursuit, as being impracticable, after incurring an expense of from sixty to eighty thousand pounds, because their ballast spoons and other implements were not sufficiently powerful nor properly constructed to penetrate the strata, which, at this part of the river, consist of strong blue clunchy clay, intermixed with layers of rock. Well knowing that these strata were impenetrable to all the ballast-lifting implements of that day, and that the Corporation of the Trinity House had, at the suggestion of the House of Commons, advertised for engineers and others to furnish plans for raising ballast upon an improved principle, I immediately in the abscence of my well known and respectable partner, Mr. William Bough, then attending to a large contract we had at the Dartmoor prison, wrote and suggested to him a mode or principle of a floating steam engine to work a dredging machine, that I thought would fully answer the intended purpose; to this he readily agreed. I immediately set about preparing it, which I was able to do in about three months: and as soon as it was ready, I proposed to the Port of London Committee to deepen and finish the East India moorings. They accepted my proposals, and I became the contractor. When I was ready to commence operations, the Port Committee came down to see the working of the engine, and were exceedingly sanguine about the success of this (at that time) novel and singular contrivance. Several trials were made in their presence, and I had the mortification to see many parts of the engine, which had cost me much expense and intense thought, torn to atoms, and links of chain, one and a half inch square, broken and snapped off, just as easy as the stalks of so many tobacco pipes, by the expansive power of the steam; finally, the machine was almost torn to pieces, and rendered useless, which was a great disappointment to me as well as to the Port Committee. Having, however, been bound under a penalty to execute the work, it was of no use to reflect on the

disasters of this day's trial, which, after all, gave me an opportunity of seeing that the engine had sufficient power to penetrate the strata; but at the same time many improvements were wanting to make the machine equal to its task, it was therefore laid up in Mr. Perry's Dock at Blackwell, and in the course of a few weeks I had my additional friction blocks fixed to prevent breakage, and several other improvements made, which, on the next trial, proved successful, to the greatest degree of perfection, and enabled me effectually to accomplish and complete my contract, to the entire satisfaction of my employers.

About this time Messrs. Milne Huddart and Rennie, civil engineers, were employed by the Navy Board to inquire into the cause and nature of the accumulation and deposit of mud, vegetable, and marine substances, at his Majesty's moorings at Woolwich. They were engaged a long time in making the necessary observations, and obtaining the desired information; and subsequently made a long report thereon, which stated that the deposit of mud, &c., in the river at Woolwich, had so increased of late years, as to render the Dockyard useless, and unfit for Government; and where there was a depth of 15 or 20 feet of water, 12 or 14 years ago, there was now no more than 6 or 8 feet. This report ended by submiting to the Navy Board the propriety of allowing them more time to make an actual survey and soundings of the river, which was granted. Messrs. Giles, then eminent land surveyors, were actively employed for nearly twelve months on this tedious and expensive survey. I had by this time constructed, at an expense of eight thousand pounds, a large and powerful floating steam dredging engine exactly on the same principle as the first, on board the Plymouth bomb vessel, which was purchased from Government for this purpose. It was far superior in power to the first, that being only a six horse power, and this one a thirty horse power. I therefore made a proposal to the Board to remove all the deposit at the King's moorings, off Woolwich, and offered not only to reinstate them, but to deepen the river several feet below the original channel. At the request of Charles Cunningham, Esq., the Commissioner at Woolwich, I brought my new dregding machine from Mr. Perry's Dock, where she had been erected, to make trial of the strata and deposit at Woolwich; the trials were continued nearly a fortnight, during which time it was clearly proved, to the satisfaction of the officers of the Dockyard, that the engine was not only capable of removing gravel and sediment, but was actually competent to penetrate several feet into the original bed of the river, which in this situation is an accumlation of mud, gravel, flint, and chalk. In one day we actually excavated and lifted the incredible and astonishing quantity of two thousand tons from an average depth of 30 feet of water, which can be proved by the Government accounts kept by the master attendant and other officers at Woolwich Dockyard. Having so far succeeded we tried no other experiments, but made further proposals to reinstate the depth of the moorings, &c., which seemed [with the sanction of the officers] to meet with the entire approval of the Board; but by this time the civil engineers before mentioned had brought in their voluminous and conclusive report, stating, that Woolwich was unfit for the purpose of his Majesty's Ordinary, and that the sediment off Woolwich Dockyard had so accumulated of late years, that it would take a period of five years to remove it, and that at an outlay of at least 152,000*l.*; and after all it would be so uncertain in its effects, that they declined entering into any further particulars, but recommended its being abandoned altogether, and that the Naval Dockyard should be established at Northfleet.

It is well known to every member in both houses of Parliament, at that period, with what violence the propriety of this immense work was agita-

ted, which was estimated at the vast sum of seven millions sterling, or upwards. Pamphlets were written on the subject and circulated in all directions; one, I believe, by the late Lord Melville; another, by the late George Rose, Esq.; and several others. We had, however, the satisfaction of being addressed officially, by the Navy Bord requesting us to send them our report to have it compared in all its bearings with the detailed reports of the engineers before mentioned; with this we of course complied, and offered in open contradiction to our opponents, to reinstate the harbor in eighteen months. This proposition and statement [so much at variance with those of the other engineers] astonished the Navy Board, and they finally declined to decide on the eligibilty of one report or the utility of the other: and with this impression, I believe, they laid the whole business before the Admiralty Board. I ought to add, that the plan of the new Dockyard and naval arsenal at Northfleet, was in such a state of forwardness, that the land at Northfleet for the intended docks was actually purchased by Government, and it was at one time fully expected that the works were to commence. But, notwithstanding all these preparations, the Board of Admiralty decided in favor of the mud engineers, with which name we were honored in some of the pamphlets of that date. The grand work at Northfleet was consequently abandoned, and we, in the end, entered into a contract with the Navy Board, whereby we undertook to restore the Woolwich moorings to their former state. How far this has been accomplished may be easily ascertained by application to Mr. Cunningham, who, I believe, at one time, much to his credit, stood alone unsupported against the opinion of those engineers who advocated the abandonment of the Dockyard at Woolwich.

JOHN HUGHES.

The preceeding extract will show that the first steam dredging engine with frames, links, and buckets, was used by my father in the year 1804, in a contract under the Corporation of the Trinity House, at the moorings opposite the East India Dock gates.

Of the advantages that have been derived by the Government and shipping interests of this kingdom, from the means afforded by the steam dredging machine, of deepening and clearing the various harbors, I am quite unable to give anything like an adequate idea. With respect, however, to its application by the civil engineer to the numerous operations connected with the improvement of navigation, it is quite certain according to the experience of upwards of thirty years, since its first introduction, that a more effective and necessary machine has never been placed under his command.

I propose now to notice the further improvements that were made in the steam dredging engine under my own inspection, whilst managing the dredging operations on the Caledonian Canal, under my late uncle, Mr. William Hughes. In order to convey a proper idea of the great value of the system of steam dredging, as practised on this important work, it will be necessary to give some description of the nature of the country through which the canal is carried, from which it will be seen that difficulties almost insurmountable would have occurred to impede the execution of the canal, had not the dredging proved effectual to the full extent of the most sanguine anticipation.

The line of country which had been fixed on for the course of the canal, comprised three deep and extensive lochs or lakes, extending longitudinally with the canal for the length of thirty-seven miles and a half, whilst a distance of about twenty-three miles intervened between the lakes. Thus it was necessary, in order to complete the communication between the eastern and western shores of Scotland, to excavate between one lake and the other,

and afterwards to deepen all the shallows that occurred in the direction through which the canal was to be carried.

The method of dredging which had been pursued by my father, as before described, on the river Thames, and subsequently by Mr. Rennie at the Hull docks, was found perfectly successful in every situation where the machine could float above the spot at which the dredging was required. The position of the buckets, however, required considerable alteration before the engine could be rendered capable of cutting her way across a neck of land, or through the various shoals which occurred on many parts of the lakes. It was accordingly found necessary so to construct and fix the ladder or bucket frame, that when lowered to the working position it projected several feet beyond the bows or stem of the vessel—an experiment, of which the ultimate success was at the time considered very doubtful, and concerning which great anxiety was felt by all those interested in the proceedings. It, therefore, afforded universal and infinite satisfaction to find that the engine worked with the most perfect ease, cutting a passage on the very first trial out of a piece of the canal [which had previously been filled with water for the purpose of floating her] through a neck of land into the eastern end of Loch Doch Four. This work having been accomplished, the engine was successfully employed in removing several extensive shoals which occurred in the lake. At the eastern end of Loch Doch Four where the water from Loch Ness falls into it, close to the ruins of Old Ness Castle, occurred perhaps the most difficult case of dredging that can well be imagined. This was occasioned by the necessity of carrying the canal along the bed of the river Ness, which discharges the water from Loch Ness, into the lower level of Loch Doch Four. The bed of the river was composed of an exceedingly hard stratification known by the term mountain clay; and it would be difficult to conceive anything more calculated to resist all efforts to remove it than this very compact and almost impenetrable substance. It occurs in great masses almost without any appearance of stratification, and entirely free from vertical cracks or fissures. Gunpowder applied in the ordinary mode of blasting was found to produce little or no effect on this clay, as it blew out of the orifice made to receive it without loosening any quantity of the mass.

The river Ness flowing over this primitive and hitherto undisturbed bed, falls into Loch Doch Four with rather a rapid current, and against this the engine had to fight her way, while the duty to be performed was the excavation of the river-bed, to a depth varying from four to twelve feet, and very often the sides had to be widened, and in places where considerable bends occurred in the course of the river, a new channel had to be formed with a breadth at bottom of fifty feet according to the regular section of the canal. It was soon evident when the engine was set to work against the current, and required to tear up the hard bed of the river, that the exercise of every possible contrivance was necessary in order to the fulfilment of this difficult task.

It was at first found impossible to keep the vessel, containing the engine steadily moored against the current, in consequence of the slipping and giving way of chains, cables, and anchors. The machinery, which was of the very best description, and constructed by the Messrs. Donkin, was quite unable to withstand the immense force applied to it, in order to make the buckets cut into and bring up the excavated clay. All the ground tackle, comprising a full complement of anchors, cables, and hawsers, was first-rate, both in workmanship and materials; the links were of the best Swedish iron; all the bolt-holes were steel-bushed; while the bolts themselves were of the best tempered steel, and case-hardened.

The whole of the buckets were not only made of the best Sweedish plate-iron, but had strong pieces of tempered steel-plate riveted to their edges. The friction-blocks throughout the engine were manufactured and fixed with most surpassing care, and could always be adjusted to act with the greatest nicety. Notwithstanding, however, all the perfection of this engine, and the constant care with which every operation was performed; the most vexatious and apparently insurmountable inefficiency, was the result of her first labors in the situation above described. It was no uncommon occurrence to witness, in rapid succession the tearing away of the buckets, the stripping of the cogs from off the wheels, the snapping of the chains, breaking of bolts, and giving way of the anchors and cables, while on more than one occasion the whole string of chain, buckets, and bolts, was carried overboard.

No sooner were the necessary repairs executed upon the shattered machinery than it was again torn to pieces, and after all no impression was made, no effect produced, on the solid and obstinately resisting mass, against which the engine was contending. Without dwelling upon the various unsuccessful contrivances which were introduced, it will be sufficient to mention at once, that none of these proved effectual until the expedient was tried of removing every alternate bucket from off the chain, and fixing, instead of it, two cutters formed of plates of iron and hardened with steel, which projected at right angles to the line of the chain, and, as this revolved, cut vertically into the ground below. Each pair of cutters, therefore, effected two simultaneous incisions longitudinally in the direction of the vessel, and the lip of the succeeding bucket descending immediately afterwards, scoops up the mass separated by the cutters, and carries it to the top of the frame. After this alteration the work of the engine was performed with much greater efficiency than before; but, in consequence of the hard and incompressable nature of the clay above described, the counter resistance offered to the buckets and cutters would have been sufficient to tear them off and otherwise derange the machinery, had this not been prevented by the action of the friction-blocks. By means of these, whenever a visible tightening and straining of the chain throughout its whole length, denoted that some extraordinary resistance was opposed to the motion of the buckets, the engine continued to work and the wheels to revolve, while the chain and buckets remained stationary. The dredging vessel was then allowed to drop back with the stream, in order to loosen the bucket, which, being thus extricated from the incision made in the ground, passes back without resistance.

The vessel is then hove up to her original position, and the next descending cutters render the previous incision more perfect, and the bucket immediately following these cutters commonly succeeded in tearing up the obstinate mass. Sometimes, however, it happened that the vessel had to be dropped from her work, and hove to it again several times before this effect could be produced.

These operations, tedious and difficult as they were, succeeded in forming the complete communication between the two lakes in the course of about four months. The distance thus dredged was about 300 yaards, and the total quantity removed about 20,000 yards. It must, however, be noticed, that the returns of the work done did not exhibit so large an amount as the above, and this is accounted for by the fact, that a great deal of the material loosened and dislodged by the cutters and buckets was carried down by the stream into deep water, instead of being raised in the buckets to the top of the frame. The excavated earth being in this way as effectu-

ally disposed of as if it had all been hauled up by the buckets; it may not appear surprising to learn that the current of the river, although seeming at first sight so obviously an obstacle to the process of effective dredging proved in the way described a great auxiliary to the power of the engine.

Another instance of the immense advantage which may be derived in some situations from the employment of the dredging engine occurred at the west end of Loch Ness. In this part of its course for a short distance out of the lake the canal runs side by side with the river, which descends from Loch Oich, the summit lake, to Loch Ness. The canal attains the level of Loch Oich by means of six locks, five of which are situate above Fort Augustus, about half a mile from Loch Ness, and the sixth at Kytra, about half way between the two lakes. The locks were founded and carried up beyond the reach of water before the canal was excavated on either side of them; and here it will be useful to observe the difficulties which would have presented themselves had not the power of dredging been applicable to this work.

In the first place, any attempt to excavate in the ordinary way between Loch Ness and the ascending locks would have been immediately followed by a deluge of water from the river, and it was certain, on account of the open and inadhesive nature of the strata between the river and the canal, that the water penetrating into the excavation made for the latter would have stood at least as high as the level of Loch Ness, which is the lowest drainage it could possibly obtain. Thus the operations of excavating must have been carried on under a depth of twenty feet of water—a case in which manual labor could not possibly be employed.

On the other hand the expedient of carrying the canal on a higher level, by building two of the locks immediately at the end of Loch Ness, and in this way obtaining drainage into the lake, would have been attended with almost equal objections, for the immense coffer dams which would have been required in getting down the foundations in such a situation would have seriously increased both the time and the cost of execution. As it was, however, by means of the dredging engine the canal was easily excavated to its full depth and breadth, from the end of Loch Ness to the tail of the first ascending lock.

The application of the dredging engine in the case just described leads us to consider one of far greater importance, where a most difficult and extensive work would have been entirely avoided, had the power of the dredging machine been as well known at that time as it has since become. Every history of the Caladonian canal dwells with great minuteness upon the difficulties experienced in building the sea lock at the eastern end of the canal where it terminates in the Beauly Frith, a part of the Eastern Sea. At this place an embankment was actually carried out into deep water, and after sufficient time had been allowed for its consolidation, the excavation for the lock was formed in the middle of it. This expedient, ingenious as it certainly was, would have been quite unnecessary if the lock had been built on the solid ground inland, and a passage had been dredged out into deep water. Although it is probable, considering the state of engineering knowledge at that time, that the plan adopted was the best that could then be devised, it is certain that a much better work could have been constructed in the solid ground before entering the Beauly Frith, and in corroboration of this it may be mentioned, that the sea lock at this day has a considerable dip or inclination towards the sea, an effect no doubt occasioned by the after settlement of the artificial mound in which it was placed.

With respect to the dredging on the Caledonian canal very little more re-

mains to be said. In various places on the west side of Loch Oich its powers were brought into requisition, but to describe the circumstances of its application at length would be merely to repeat what has already been told, with reference to Loch Doch Four, and Loch Ness.

Without any disposition to disguise the fact that difficulties serious and annoying occasionally presented themselves, I am quite safe in asserting that in every case a persevering and determined application of the dredging engine, in the capability of which every one engaged placed the most implicit reliance, succeeded without exception in a complete fulfillment of the duties expected and required. As it may be interesting to know the quantities of work performed by the engines on this canal, the following numerical statement may safely be depended on. The total quantity of dredging on the Caledonian canal exceeded one million of cubic yards, and the engines employed were only two in number, a six and ten horse power. The former of these was employed in the dredging out of Loch Ness up to the first ascending lock, in which district the quantity dredged amounted to 170,000 cubic yards and occupied eight months. This engine was also employed in dredging through the shoals of Loch Doch Four, and between this lake and Loch Ness. The ten-horse power engine was built at Loch Oich, in the year 1816, and was employed in dredging into the lake through the shallows, and between the summit level and Loch Lochy descending westward. The greatest quantity raised in one day by the ten-horse-power engine on the Caledonian canal was 1500 tons.

In reviewing the extraordinary peformance of the dredging engine in every situation where it has hitherto been employed it appears to afford to the engineer means of the most powerful and extensive capability in the construction of a class of works which must ever hold a place of great importance in the rank of engineering operations. I allude to docks and harbors, in the construction of which, during late years, the greatest acquirements, both practical and scientific, have been called into action. The well-attested performances of the dredging engine clearly establish the fact that this machine, being set to float in a basin or a channel of water, is capable not only of tearing up and deepening the bed, however hard or solid but also of cutting away the adjacent land, and extending either the length or breadth of the body of water in any required direction. In the same way the engine would be quite competent, when placed out at sea, to work inland, either to clear out the *embouchure* of old rivers, docks, or harbors, or, as a still bolder undertaking, to excavate new channels where the old ones from any cause have been impeded and rendered useless. The design of constructing docks, harbors, and basins of any kind in sheltered situations, at any convenient distance from the sea, may be safely carried into effect, relying on the power of the dredging engine to perfect the communication with the sea, at an expense not exceeding that of ordinary excavation.

To enter into details respecting the cost of dredging in various situations would be out of place in a paper of this kind, which professes to be a mere outline of its advantages. But I shall at any time feel great pleasure in affording to any individual, or public body, who may think proper to communicate with me on the subject, the benefit of my experience and practical acquaintance from earliest youth, with every particular relating to the practice of dredging by steam power.

THOMAS HUGHES.

4, Acre-lane, West Brixton.
December 15, 1838.

St. Petersburg Railway—At a General Meeting of the Shareholders in the Zarskoe Zelo Railway, held at St. Petersburgh at the end of April, it appeared by the report of the Directors that the cost of the formation of the road and its material had amounted to 5,281,667 roubles. *The original calculations were founded upon the anticipation of* 300,000 *passengers within the year, but during the preceeding* 12 *months the number of travellers between the capital and Zarskoe Zelo had amounted to* 500,000, *and the number which passed along the whole line to and from Paulowsk was* 707,091. The receipts amounted to 920,237 roubles. At the end of the first nine months the receipts exceeded the expenditure by 316,976 roubles. Of this balance 90,000 roubles were applied in paying the interest and reimbursing the loan from the crown; and 140,000 roubles to the payment of interest on shares; 15,848 roubles were divided according to the statute among the Directors; 1,555 roubles were paid to the chief engineer; and 69,572 roubles were carried to the reserved fund.

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Monroe Railroad Extension.—It will no doubt, be learned with pleasure by our readers, that the location of the road has just been completed, and all the contracts for grading have been taken or engaged, from Forsyth to the State road in De Kalb. This has exceeded the most sanguine expectations of its warmest friends, and great credit is due to those who superintend its interests, for the energetic manner in which the work has been conducted. No doubt remains that this road could be completed in fifteen months from this time, if sufficient funds were at command, or could be obtained, to procure the iron by the time it will be needed. Great difficulties have been surmounted in the worst of times, in carrying on this work, and we trust that this will be. Great advantages will be acquired by the road, and also by our citizens by its early completion.—*Macon Messenger, 29th August.*

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## REPORT OF THE ENGINEER TO THE PRESIDENT AND DIRECTORS OF THE LITTLE MIAMI RAILROAD COMPANY.

*To the President and Directors of the Little Miami Railroad Company.*

Gentlemen—The following statement of the result of the survey for determing the route, and ascertaining the probable cost, of constructing a Railroad from the city of Cincinnati to the town of Springfield, is respectfully submitted.

The located line, from Cincinnati to Milford, occupies, with but few exceptions, the same ground as that surveyed by R. H. Fauntelroy, resident Engineer, under the direction of Samuel Forrer, Esq., consulting Engineer; and is, beyond doubt, the most judicious location that could be made.

From Kulgar's Mills to the point where the Lebanon and Chilicothe Road crosses the river, an instrumental examination was carefully made of both sides of the river, which resulted in giving preference to the east side.—High bluffs and precipitous banks occur more frequently on the west side: in many instances the river makes so near the base of the hills, and is so serpentine in its course, that curves of 500 feet radii must be employed to afford deflections sufficiently abrupt to psas them without incurring a heavy expense for constructing the Road entirely in the bed of the river, or making heavy excavations in side hills that are subject to continued slips.

The two routes are about equal as to grades, but in respect to curvature, a considerable superiority belongs to the line on the east side of the river; the minimum radius employed on the latter side being 800 feet. The line

on the west side is 1.42 miles longer than the east line, and its estimated cost exceeds the cost of the latter $40.142 13. From the intersection of the two lines, near Lockport, north, but one line has been surveyed. The frequent bluffs and slips on the west side of the river, none of which appear on the east, are, in themselves, sufficient to warrant a decision in favor of the latter side. The general direction of the line, while within the influence of the Ohio and Little Miami rivers is quite circuitous; yet there are but few instances where we are compelled to resort to curves of less than 2000 feet radii. In all cases where the curves are abrupt, the grades are nearly or quite level, so that in no instance will the line, curved with the minimum radius, with the adopted grades, offer a resistance to the action of a locomotive engine equivalent to that due to gravity, where the ascent exceeds 20 feet in a mile.

### DESCRIPTION OF LINE.

The location commences at the corporation line, near the centre of High street, and runs along the face of the hill nearly parallel with the turnpike for three miles; at the commencement of the fourth mile it crosses the turnpike and Crawfish creek. The valley of this creek, where the line crosses it, is 900 feet wide; it is proposed to pass it with a bridge at an elevation of 30 feet. From this creek the line follows the base of the hill—recrossing the turnpike at J. D. Langdon's; thence up the valley of Duck creek to C. D. Langdon's, where it again crosses the turnpike and enters the valley of the Little Miami river at the "red bank." From the "red bank" it continues along the side hill for one and a half miles, when it enters the bottom land, and continues thereon to the narrows, on the 11th mile; at this place it will be necessary to protect the banks with stone, in order to avoid the encroachments constantly made by the river.

On the 11th mile the line enters the valley of Highland's creek, running along the western side, it crosses the summit between that and Mill creek, in the vicinity of W. Highland's house, and re-enters the valley of the Little Miami river opposite the town of Milford. From the toll-gate, at Milford, the line follows the serpentine course of the river for one mile, when it again leaves the valley and enters the elevated second table in the rear of M. Kulgar's Mills. It keeps at the same elevation until within a short distance of the Little Miami river, on the 17th mile. From this point two lines were run, one on each side of the river. The features of the two lines, to their intersection near Lockport, are quite similar—so that a particular description of both is not necessary.

The *east line* crosses the river at the "Indian Ripple," a short distance below Buckingham's mill, and continues upon the second table, until the narrows are reached, opposite the lands of W. Goldtrap; at this place it will be necessary to build the road partly in the river for several hundred feet, in consequence of a sudden bend in the river and the precipitous character of the banks. Loose rock is to be had in sufficient quantities in the immediate vicinity, to build the necessary protection wall.

From the "Narrows" the line is laid upon first and second bottom, until opposite the "Company Mills," when it again follows the bluff banks of the river for a short distance. No obstacle presents itself at this point to a cheap and permanent location, as the bluff falls with a gentle slope, and shows no evidence of slips. Between this point and the mills of W. Ballard, the ground is highly favorable, being mostly bottoms, sufficiently elevated to be out of the way of high water.

The line crosses Obanion creek, at a favorable elevation, near its mouth, and continues on the bottom with but one minor exception, to a point oppo-

site the mills of Gov. Morrow. On the 27th mile the ground is broken and subject to inundation, but the great abundance of stone which may be had here, as well as at almost every other point on the river, will materially reduce the expense of construction. From the 28th mile, opposite the mills of J. Phillips, to the crossing of "Todd's Fork," on the 37th mile the features of the valley are generally favorable. From the mouth of "Todd's Fork" the same favorable features are observed, both as to grades and curvature, to the narrows, a short distance above Millgrove. Here, for several hundred feet, the bluff banks on both sides make directly into the river, rendering it necessary to adopt a curve of 800 feet radius, in order to secure the most desirable location.

On the first quarter of the 42nd mile, the two lines connect, and the survey continues up, on the east side of the river. At Lockport, on the 4th quarter of the 42d mile, it will be necessary to protect the road from the action of the river.

Proceeding from Lockport north, the valley increases in width, and the hills lose those rugged features which characterise them south of that point. The line continues on the bottom land, crossing Cæsar's creek near the present "ford." On the first quarter of the 51st mile we are opposite the village of Waynesville, and 305 feet above the Ohio river. Between Waynesville and Xenia, a more favorable location could not be desired, the country being mostly open prairie. The earth coming from the ditches will for a greater part of the distance, afford the material for the embankments.

The line crosses the Xenia and Cincinnati road about 700 feet east of the present road bridge—enters Glady valley near its mouth—pursues it to the low summit dividing the waters of Glady and Shawnee rivers, and enters the town of Xenia, on the 3d quarter of the 65th mile, at the foot of Detroit street.

The foundation of the court house in Xenia is 498.1 feet above the surface of the water in the Ohio river, as observed 6th November, 1838. From Xenia north, we continue a straight course parallel with Detroit street—the present travelled road diverging to the west, when we curve to the west, cross the old road, and pursue the course of a ravine down to "Old Town bottom." In crossing the valley of "Old Town run," an embankment of 11 feet is necessary for one thousand feet. Thence the line continues along the base of the hill bounding "Old Town bottom," crossing Massie's creek at an elevation of 14 feet, and continues to ascend until it reaches the high land two miles below Clifton—thence descending gradually to the town of Clifton. The Little Miami river is crossed between the present road bridge and Bates & Lewis' flouring mill.

From Clifton to Springfield the route is very favorable. For the first five miles the line is laid upon open prarie—the next three miles are rolling timbered land: nothing, however, opposing a cheap and favorable location. The line falls into the valley of "Mill run," a short distance east of Springfield, and continues down the run to an intersection with Spring street, the terminating point of the survey. The termination is approached with a straight line and a level grade, and is at an elevation of 534 feet above the Ohio river.

The entire distance from the corporation line of the city of Cincinnati to the town of Springfield is 85.2 miles.

I have divided the line into six divisions, and as the detailed estimates are too voluminous to accompany this report, I have given the amount only for the graduation, masonry and bridging of each division, the cost of superstructure being almost invariable, will be the same per mile for the entire line.

ESTIMATES.

| | |
|---|---|
| For graduation, masonry, &c., of division 1, extending from the corporation line to Columbia, 3.60 miles, | $24,848 91 |
| For graduation, &c., of division 2, extending to Kuglar's mills, 11.68 miles, | 51,158 50 |
| For graduation, &c., of division 3, extending to Lockport, 25.66 miles, | 118,565 52 |
| For graduation, &c., of division 4, extending to Greene county line, 13.50 miles, | 38,522 76 |
| For graduation, &c., of division 5, extending to Xenia, 10.32 miles, | 16,010 10 |
| For graduation, &c., of division 6, extending to Springfield, 20.44 miles, | 82,731 44 |
| Total for the graduation, masonry, &c. of the entire line, | $331,837 23 |
| For 85.2 miles superstructure, as per estimate A, $5024 per mile, | 428,044 80 |
| Add for depots, side tracks, &c., 10 per cent, | 75,988 20 |
| Add for engineering, 5 per cent, | 41,793 51 |
| Total for 85.2 miles, | $877,663 74 |

Or ten thousand three hundred and one 21-100 dollars per mile.*

The above estimates were made to include the cost of a single track, together with the necessary side tracks. The facilities for transportation afforded by a single track railroad when provided with suitable side tracks are very great, and without doubt will be found adequate to the business of the road, however much it may be increased. This is rendered the more certain by the perfection attained in the application and management of locomotive power. It is now so well understood, that the time of meeting at the different passing places may be so arranged as to prevent all danger of collision.

The plan of superstructure for which the estimates were made, is similar to that adopted on the Utica and Schenectady Railroad, and most other roads in the northern and western states. It consists of a sill 4 by 12 inches, either hewed or sawed, upon which rest cross ties 8 feet long and three feet from centre to centre, secured by locust tree nails. The rails are to be 6 by 7 inches, secured in a notch in the tie by white oak wedges. The estimated cost of this superstructure is $5024 per mile, as per estimate A.

I have estimated 31 1-2 tons iron to the mile, which is the weight of a bar having a transverse section of 1 by 2 inches; a bar 2 1-4 by 7-8 inches weighs nearly the same per mile. I would recommend a rail plate with two inches upper surface, 2 1-2 inches base, and 7-8 inches thick: this rail would offer a greater bearing surface upon the timber than one 2 1-4 by 7-8 inches, and would be nearly as inflexible as a bar of 1 by 2 inches. It would be inexpedient to adopt a lighter bar, but should a bar of 2 1-4 by 5-8 inches be adopted, the price, per mile, of superstructure would be proportionally diminished.

The grades are generally favorable, the maximum being 40 feet per mile. This inclination is easily overcome by locomotive engines with loads of from 75 to 100 tons, at a velocity of 10 miles per hour. Recent

* Divisions 2 and 5 were put under contract in December last, and the grading is now well advanced.

experiments for determining the power of traction of locomotive engines have produced much greater results. An engine manufactured by M. W. Baldwin, has drawn over the Columbia Railroad—a part of which has an ascending grade of 45 feet per mile—35 loaded cars weighing 187 tons, at a speed of from 8 to 12 miles per hour, as certified by Mr. J. Brant Superintendent. An engine manufactured by W. Norris, of Philadelphia, drew over the same road a train of 41 loaded cars weighing 198 tons, around short curves, and up an ascent of 51 feet per mile, at the rate of 10 miles per hour. The same engine drew a load of 104 tons up an inclination of 40 feet per mile, at the rate of 15 miles an hour, as certified by the weigh master of the road. Upon the Baltimore and Ohio Railroad locomotive engines are in constant use upon grades of 35 feet per mile, where the road is curved with a ridius of 400 feet, as is shown in the tenth annual report of Jonathan Knight, Esq., Chief Engineer. Mr. Knight estimates the friction due to curvature of 400 feet radius at 6.5 pounds per ton, inclusive of engine and tender, which is equivalent to the gravity of a ton upon an inclination of 1. in 345, or 15.3 feet per mile. Numerous other experiments have produced results that fully sustain the above assertion.

The grades are arranged in the following order:

| | MILES. | FEET. |
|---|---|---|
| Level, | 9 | 2990 |
| Level to 10 feet inclination per mile, | 37 | 2080 |
| 10 to 20, | 16 | 4320 |
| 20 to 30, | 9 | 3440 |
| 20 to 40, | 11 | 4020 |

From the above it will be seen that for more than one-half the distance the grades are under 10 feet per mile, and that for but one-eight of the distance do they exceed 30 feet per mile: there are but few instances where the grades exceed 35 feet per mile.

It is an important feature in the profile of the Little Miami Railroad that presents a descending grade for almost the entire distance from Xenia to Cincinnati. This inclination, when considered with regard to the business of transportation, is in the direction favorable to the great preponderance of trade. The heaviest grades occur north of Xenia, in descending into the valley of the "Old Town Run," and ascending from the valley of Massie's creek to the town of Clifton. These grades, from their location, will not importantly affect the business of transportation. Trains for the ascending trade, leaving Cincinnati with loads equal to the maximum power of their engines will, on their departure from Xenia, have discharged a sufficient amount to enable them to pass the heavier grades between Clifton and Xenia, without decreasing their speed.

Trains for the transportation of passengers are seldom loaded to such a degree as to require a diminution of speed upon grades similar to those adopted on this road, and may, without difficulty, maintain velocities of from 15 to 20 miles an hour, while trains for the transportation of freight and passengers may travel at the uniform rate of 15 miles an hour.

It is encouraging to reflect, that the result of the examinations in detail fully demonstrates the practicability of constructing a road that will admit of the favorable application of locomotive power, at a medium expense when compared to the cost incurred in the construction of similar works.

From Xenia north, the features of the country are such as will admit of several lines, although one only was surveyed. My instructions being

more particularly to give the valley of the Little Miami river a thorough examination, together with the limited time allotted for the surveys, prevented an examination of more than the one line; this line is susceptible of some improvement. It is not improbable that a line may be had that will present more favorable grades, and upon which the road may be constructed at a less expense.

The cost of the road, from Cincinnati to Xenia, would be as follows:

| | |
|---|---|
| For grading, &c., of sections 1, 2, 3, 4, and 5, | $249,105 79 |
| 64.76 miles superstructure, at $5024 per mile, | 325,354 24 |
| | 574,460 03 |
| For depots, side tracks, &c., 10 per cent, | 57,446 00 |
| | 631,906 03 |
| For engineering, 5 per cent, | 31,595 30 |
| | $663,501 33 |

Making an average of ten thousand two hundred and forty-five 69-100 dollars per mile.

Data cannot be obtained for estimating the probable revenue of a road as accurately as its cost; yet, from the peculiar location of the Little Miami Railroad, we may arrive at a more correct result than is usual in such cases. From the connection of this road with the most important lines of intercommunication of the west—when we consider that during the suspension of navigation of the Ohio river, a large amount of travel between the east and the southwest will become accessary to this road, it is obvious that the number of passengers will far exceed our most sanguine expectations. The Little Miami Railroad will become of importance for the rapid transmission of the United States mail—the receipts for which will also add to the revenue. We can form some idea of what will be the amount of freight transported on this road by a comparison with that transported on the Miami Canal between Cincinnati and Dayton—their locations being quite similar—and it cannot be doubted that the increased business consequent on the increasing population of the country, together with that incident to the advantages due to the certainty and celerity of railroad operations, will, for the entire year, offer a business to this road equal to that done on the canal the past season of navigation.

In 1838 there was shipped from Cincinnati 20,986 barrels of salt, 39,250 bushels of coal, and 8677 tons sundries, inclusive of merchandize, &c. There arrived at the same port 205,891 barrels of flour, pork, whiskey, &c., 3891 tons sundries, inclusive of merchandize, &c.

There was shipped from Dayton in the season of 1835, 106,900 barrels of flour, pork, whiskey, &c.; 3148 tons transient freight. There arrived at the same port 6404 tons sundries, inclusive of merchandize, &c., as is shown in the Canal Commissioner's Report for 1838.

A large amount of flour shipped from Dayton, and the intermediate ports, is manufactured on the Little Miami river, and will, on the completion of the Little Miami Railroad, become tributary to its business. "The amount of pork and wheat produced in Greene county alone, in the year 1838, as taken by the assessor of the county at the request of the Greene County Agricultural Society, was 3,192,353 pounds of pork, and 258,157 bushels of wheat." From the statement of the millers and produce dealers, I find that there is now manufactured for annual exportation, on the Little Miami river and its tributaries, and in the immediate vicinity of the

line of the Railroad, 175,650 bbls. flour, 50,450 bbls. pork and whiskey; and that the exports of transient freight amount to 1473 tons. The average distance of the transportation will be about three-fourths the length of the road; yet it would be unjust to allow but for the present business, as every individual with whom I conversed, assured me that his business would become at least doubled if he possessed facilities for exportations, and we consider ourselves safe in averring that the increase will more than compensate, if we allow the entire length of the road as the distance for the transportation of the present products.

| | |
|---|---|
| From the above we deduce for the annual receipts of the road, as per estimate B, | $174,700 00 |
| Deduct for managing the road, one year, as per estimate C, | 73,110 00 |
| Leaving as a net revenue, | $101,590 00 |

Which is 10 per cent on $1,015,900.

As the estimate of the revenue is based upon the present busines of the country contiguous to the line of the road, it cannot be doubted that the Little Miami Railroad will amply remunerate all those who aid in its construction.

The surveys and estimates have all been made with much care, and from the vigilance and attention of Wm. H. Clement, my principal assistant, I am confident that no important feature in the topography of the country was passed unnoticed. R. M. Shoemaker, *Engineer,*

*Little Miami Railroad.*

[A]

ESTIMATE FOR ONE MILE OF SUPERSTRUCTURE.

| | | |
|---|---|---|
| 37,171 | feet B. M. rails, at $12, | $446 52 |
| 42,240 | feet B. M. sills, at $12, | 506 88 |
| 1760 | cross-ties, at 25 cents, | 440 00 |
| 3520 | wedges, at $7, | 24 64 |
| 3520 | tree nails, at $3, | 10 56 |
| 530 | splicing blocks, at 3 cents, | 15 90 |
| 1300 | lbs. spikes, at 12 cents, | 130 00 |
| 2 | road crossings, at $10, | 20 00 |
| 520 | lbs. splicing-plates, at 10 cents, | 52 00 |
| 31½ | tons iron, at $85, | 2677 20 |
| Workmanship, | | 700 00 |
| | Total for one mile, | $5024 00 |

[B]

ESTIMATED ANNUAL RECEIPTS OF ROAD.

| | |
|---|---|
| 150,000 bbls. flour, at 30 cents, | $45,000 00 |
| 50,000 " pork and whiskey, at 40 cents, | 20,000 00 |
| 1400 tons bulk pork, and transient freight, at 6 1-2 cents per ton per mile, | 7,700 00 |
| 80 passengers, (40 each way) per day, at $2 50, 300 days, | 60,000 00 |
| 5000 tons merchandize, &c., at 6 1-2 cents per ton per mile, | 27,500 00 |
| 10,000 barrels salt, at 30 cents, | 3,000 00 |
| 30,000 bushels coal, at 5 cents, | 1,500 00 |
| Transportation of United States Mail, | 10,000 00 |
| Amount, | $174,700 00 |

[C]

ESTIMAPE FOR MANAGING THE ROAD ONE YEAR.

| | | |
|---|---|---|
| 1 | Chief Agent and Superintendent, | $3,000 00 |
| 2 | Collectors, at $1500 each, | 3,000 00 |
| 4 | Conductors of trains, at $800 each, | 3,200 00 |
| 2 | Clerks, at $500 each, | 1,000 00 |
| 5 | Engine men, at $700 each, | 3,500 00 |
| 5 | Firemen, at $350 each, | 1,750 00 |
| 30 | Laborers, at $350 each, | 10,500 00 |
| 3 | Collectors, intermediate, at $700 each, | 2,100 00 |
| | Repairs of engines, cars, &c., | 10,000 00 |
| | Repairs of road, renewals, &c., at $300 per mile, 10 per cent on the perishable material, | 25,560 00 |
| | Fuel, &c. | 8,000 00 |
| | Office expenses, advertising, &c., | 1,500 00 |
| | Total for managing the road 1 year, | $73,110 00 |

THE FIRST ANNUAL REPORT OF THE DIRECTORS OF THE ANNOPOLIS AND ELK RIDGE RAILROAD COMPANY.

*To the Stockholders of the Annapolis and Elk Ridge Railroad Company.*

The Directors submitt the following report, of the operations for the year ending on the 8th of October, 1838; and a statement of their receipts and disbursements since the organization of the Company.

The books of subscription were opened in Annapolis and Baltimore, and at the Savage, in the Spring of 1837, under the direction of the Commissioners named in the Charter, and subscriptions to the amount of $52,000 were obtained. A general meeting of the Stockholders was called at Annapolis, on the 6th day of June, 1837; when the following gentlemen were elected Directors, Elias Ellicott, John Johnson, Somerville Pinkney, Thomas S. Alexander, Dr. Dennis Clude and John Miller. On the following day John Johnson, was elected President, George W. Hughes, Engineer, and Nicholas H. Green, Secretary.

The Engineer was instructed to organize his corps, and to proceed immediately to locate the route of the road. The preparatory surveys were made in the course of the ensuing autumn, and were submited to the board and adopted on the 6th of February, 1838.

It was not, however, until the 20th of April, 1838, that the board determined to advertise for proposals, for the graduation of the road. Proposals were accordingly received, and on the 29th day of May, 1838, the board contracted for the graduation of the whole line of the road, and for all the masonry on the road. These contracts amount to $158,157. About the middle of June, the several contractors commenced the execution of the work which has been vigorously prosecuted under the direction of the Engineer. The company was deprived of the valuable services of Mr. Johnson, as President, by his resignation on the 26th day of May, 1838; and Somerville Pinkney, was elected in his stead.

The Directors on the 6th of June, 1837, made a requisition on each stockholder for an installment of four dollars per share, the payment of which was completed so as to enable the company in May last, to receive from the State of Maryland the sum of $15,000; a further requisition was made on the 21st day of April, 1838, for the sum of five dollars per share, payable on the first day of July, and of five dollars per share payable on the first day of August last. The first mentioned installment was paid in

time to enable the company to draw on the Treasurer for $15,000; which was received early in September, the other payment was finished so as to put the company in a condition to obtain the further sum of $15,000, on the first instant, from the State.

The corporation of the City of Annapolis by the provisions of several by-laws, lately passed, have agreed to anticipate the City subscription, and under these by-laws the company has received $6,000 in cash, and $2,500 to in certificates of stock of the City, bearing 6 per cent interest, which it is believed can be easily converted into money. The Directors were induced to make the arrangement with the Corporation, by which interest is to be allowed to the City on its advances, from the time thereof until the installments shall be duly payable according to the Charter, for the double reason that it was a relief to the City, and a considerable aid to the Company, its contracts exceeding its immediate available means. They have thus been enabled to meet all the engagements, to the first day of the present month.

The operations of the Company would be greatly advanced, by the stockholders complying with the provisions of certain resolutions, passed on the 1st instant, by which it was proposed, and is now proposed to the stockholders to anticipate their subscriptions, or to advance the installments which will be payable on the 15th November, 15th December and 15th January next. The Directors confidently expect that the stockholders will without hesitation comply with this suggestion, because the State's installments are not payable, until each individual stockholder has paid his installment, and because the State's Treasurer is dependent upon the Chesapeake and Ohio Canal Company, for means to discharge the installments required from the State. The first installment now called in becomes payable on the 15th of November next, and will bring into the Treasury of the Company after that day $17,600.

| | | |
|---|---|---|
| There has been paid by each stockholder on eash share the sum of $15 amounting to | | $7,801 |
| By the State of Maryland | | 45,000 |
| By the Corporation of Annapolis, in anticipation | | 6,000 |
| And the Company has borrowed | | 9,000 |
| | | $67,801 |
| And there has been expended for the right of way, including expenses of Jury and Sheriff's fees | 12,127 90 | |
| Expenses of Engineer's department, in purchasing tents and instruments, pay of Engineer and assistants, provisions of party and other expenses in locating and surveying the road | 7,942 62 | |
| Printing, furniture, discount and other incidental expenses | 468 07 | |
| Salaries | 400 00 | |
| Graduation | 20,219 58 | |
| Masonry | 6,436 08 | |
| | | 47,594 25 |
| | | $20,206 75 |

Leaving a balance to the credit of the Company on the 4th October, 1838, in the Farmers' Bank of Maryland of $20,206 75.

This ballance, however, is subject to the payment of the estimates to the 1st of October; which were not fully ascertained when this report was prepared. All which is respectfully submitted,

By order,

SOMERVILLE PINKNEY, *President.*

*October 5th,* 1838.

OFFICE OF TOPOGRAPHICAL ENGINEERS,
Washington, D. C. Jan. 30th, 1838.

*To the President and Directors of the*
*Annapolis and Elk Ridge Railroad Company.*

GENTLEMEN:—On the 7th of June last, I was honored by the appointment of Engineer to your company, with instructions to proceed with the survey and location of the Annapolis and Elk Ridge Railroad, with as little delay as possible; but it was not until the 28th of July, that the instruments and tents could be procured, and other necessary arrangements effected, preparatory to the commencement of field operations.

We found the surveys, which had been executed in 1836, under my instructions, for the Potomac and Annapolis Canal, of great service as regards a knowledge of the general characteristics of the country through which our road must necessarially pass. But, although those surveys answered the purposes for which they were made, yet the principles which should govern in canal and railroad locations, being so widely different, it became necessary to make other and numerous experimental surveys, for the purpose of ascertaining the minute features of the ground, before the location should be commenced. A reference to the maps, will show how completely those lines have covered the surface of the country, by tracing out the secondary ridges and valleys formed by the drainage from the principal ridge, dividing the waters of the Severn from those of the Patuxent. It is unnecessary to enter into a detailed description of those surveys, as the map sufficiently explains their nature, and the objects for which they were made.

The maps have been drawn on the large scale of 1 mile to 6 inches, which admits the delineation of the surface of the country with great minuteness and precision, and will enable the Board to form a correct opinion of the character of the line which I have selected and traced for the definitive location. The yellow color designates the experimental lines, the red, the trace of location, and the blue, the canal surveys.

Profiles have been drawn of the location, but not of the experimental surveys, as it would have required more time, without any adequate result, than we had leisure to bestow for that purpose. Profiles have been drawn on a horizontal scale of 1 mile to 6 inches, and a vertical scale of 25 feet to one inch, producing a distortion in the vertical plane from the horizontal of 35 1-6 : 1. This disproportion has been given for the purpose of showing distinctly all the inequalities of the ground, and to enable us to calculate *rigourously* the amount of work necessary to be done. The black figures on the ordinates of the profiles, denote the levels in relation to the plane of reference; the red figures, show the depth, of cutting or filling, according as they are placed above or below the grade line; and the amount of cutting and filling is also designated on the profile. It has been my object to give on the maps and profiles, all the details which may be necessary to a proper understanding of the subject.

The location has been divided into sections, with a view to equalize as nearly as possible, the excavation and embankment. To do this precisely is of course impracticable, but it will be seen that on the more difficult and expensive portions of the road, we have been very successful in our efforts

to establish this equilibrium, I have given on the several sections both the excavation and embankment, but the estimates of cost are made only for the larger prism, having a view in arranging the prices, to the distances it would be necessary to haul the cutting (if it be the larger quantity,) to form the filling, and *vice versa.* The contractor in making his bid is guided by the same consideration, and expects to be paid only for one quantity. On some roads it has been customary to call all the work excavation, and if there should be more filling than cutting on a particular section, a measurement is made of a ridge or hill in the vicinity, whence the dirt is taken for the embankment; and the amount thus taken for the embankment, over and above the excavation from the road bed [if any] is paid for as excavation. This is more simple, and perhaps rather more correct than the usual method, because the *precise* amount of work is then paid for; whereas if the embankment be measured before it is well settled, the contractor is paid too much, and if the measurement be not made till after it has become completely consolidated, he is paid to little. In cases where it would be necessary to haul for a long distance to form embankments from the road excavations, it would be more economical to allow the contractor to deposite on spoil banks as much of his cuttings as he likes, and to permit him to excavate for this purpose nearer to his work. But this indulgence should be granted only in particular instances. Wherever there is a deficiency of cutting to ballance the filling, it is proposed to make up the difference by widening the road bed, and diminishing the slopes. This may be done in almost every instance on our line, which will render the road bed more commodious and permanent, while a saving will be effected in the condemnation of lands.

Our surveys were commenced at the 18th mile stone from Baltimore, on the Washington Branch Railroad, 168 6-10 feet above tide, as a permanent point of reference. The first lines were run with a view to ascertain if the fall between the point of beginning and the head of Severn, could be equally distributed; but it soon became apparent that no such graduation could be effected without giving such a trace to our road as would destroy its usefulness, in regard to the great objects for which it is designed; and that whatever line should be finally adopted, as the definitive location, must conform measureably to the broken and waving nature of the ground. A system of undulating grades is not considered very objectionable, when, as in the present case, the trade and travel will be nearly equal both ways, and the gradients are restricted within proper limits. When the tonnage is equal in both directions, the British Engineers, so far as motive power is concerned, consider a road of undulating grades, which do not exceed 21 feet per mile, as equivalent to a level way, on the principle, that what is lost in ascending is gained in descending. This maximum of 21 feet to the mile or 1-251 has been ascertained by experiments to be the "plane of spontaneous descent," or the declivity on which a loaded car will descend under the influence of gravity alone. This declivity of spontaneous descent depends upon the amount of resistance to gravity, and this amount of resistance depends upon the perfection of the road and of the cars moving on it. Great improvements have been made, and are still making, in the principles and construction of railroad machinery. Wood, in the first edition of his treatise on railroads, states the resistance or friction at 1-200 part of the load, but in the second edition of the same work, he considered it as equal to the 1-240 part of the load. Since that time, improvements in this country, have reduced this resistance to the 1-280 part of the load, or 8 lbs. per ton. On the assumption that this is the actual amount of resistance on a well constructed road, the plane of spontaneous descent is 18.86 feet per

mile, or in round numbers, 19 feet per mile: and this corresponds very nearly with Pambour's experiments on the Liverpool and Manchester Railway. I have recently been informed, that on the new track of the Boston and Lowell road, [probably the best track in the United States,] cars have descended spontaneously a declivity of less than 9 feet per mile. If this be a correct statement, the experiment must have been made under the most favorable circumstances, and cannot therefore be regarded as establishing a principle which can be safely adopted in practice. It does, however, reduce the resistance far below any thing that had been anticipated, and speaks volumes in favor of the perfection they have attained on that road, in the construction of the roadway and cars.

In a subsequent part of this report will be found a table of gradients. I had made calculations of the power necessary to move a given weight over each of those gradients in a given time; but they have been destroyed, and I have not leisure at this time to replace them. It will be seen, however, by examining the table, that the gradients are quite moderate when compared with most railroads in this country; and as the performance of locomotive engines over different grades is well understood, in a popular form, it would be quite superfluous in me to enlarge on the subject, or to enter into any scientific analysis of their power.

It may not be inappropriate, however, to state, that recently, on the opening of the Baltimore and Susquehanna Railroad, an engine weighing nine tons, constructed under the direction of George W. Whistler, carried up an ascent of 84 feet to the mile, in addition to its tender, two passenger cars, containing 140 passengers, a distance of two miles, in seven minutes; being at the rate of nineteen miles to the hour, nearly. An engineer who was present on the occasion, writes to me as follows:--"This [the above mentioned performance] was by no means equal to the full power of the engine. Its maximum, I believe, has never been tested." We have but two grades on our road, as high as forty feet to the mile, and between 30 and 40 feet, only three grades; and these high grades are for short distances. Reference is also made to the accompanying table of curves, by which it will appear that the radii on the line vary from 1795 feet to 10,560 feet or two miles. The next shortest is 3000 feet, and more than half are at least a mile long. Very few roads present such easy curves.

These facts will enable you to form a pretty correct opinion of the facility with which your passenger trains may move with locomotive engines of moderate weight.

After all the experimental lines had been finished as far as Warfield's, and the field work plotted, it was perfectly obvious that our location must pursue nearly the crest of the dividing ridge, between the drainage into the Patuxent and Severn rivers; keeping, however, rather in the valley of the former and crossing the streams near their sources, except the two most important creeks—Chandler's or Dorsey's run and Rogue's harbor, both of which rise far up in the ridge. The former leads up towards the Patapsco, and the latter affords an easy pass to the Severn, and was contemplated as the canal route to Annapolis. It was not our object, however, to reach the Severn, but to occupy the elevated country, and thus avoid the worst ravines and ridges, all the way to Annapolis. The only streams of any consequence that we are forced to cross are Chandler's run and Rogue's harbor, as already stated. It is proposed to span the former with a wooden trestle, or pile bridge; and it would also have been recommended to pass the latter in the same way, but in arranging the grades it was found that the amount of cutting in the vicinity would be amply sufficient to make a permanent embankment, and at less cost than the expense of a wooden struc-

ture. A stone culvert will therefore be substituted to carry off the water. All the other streams, as it has been already mentioned, are crossed near their sources, and nothing more is therefore requisite than small culverts to pass off the water from springs and rain.

If our location had been carried nearer to the Patuxent, we should have been forced to adopt a far more circuitous route, with steeper grades, shorter radii of curvature, more expensive excavations and embankments, and numerous bridges and culverts. A singular feature of this country is, that the lateral ridges are higher than the main or dividing ridge, and that the laterals rise towards the Patuxent, and do not fall off till they approach the river, in consequence of which, the most level ground is generally found on the very summit of the dividing plateau.

The formation of the country naturally divides our line into three divisions, in reference to its topographical features, which of course influence the cost of construction.

1st. That portion of the line included between the Washington Branch Railroad, and the head of Severn river, in the neighborhood of Phil. Warfield's.

2d. Between Warfield's and the 15th mile, on the farm of Leonard Iglehart.

3d. Between Iglehart's and Annapolis.

### FIRST DIVISION.

This division commences near the 18 mile stone from Baltimore, in the vicinity of the Savage Factory, and of the valuable granite quarries of the Patuxent. Our location unites with the Washington road on a large curve, by two curves, one turning in the direction of Baltimore, and the other towards Washington, presenting in each direction reserved curves, which will enable burden cars and passenger trains, if it should be thought advisable, to pass with undiminished velocity from one road to the other. It is not probable, however, that any advantage will be found in running the passenger trains further than the junction of the two roads; and the location has been so adjusted, that the trains may be brought along side the Washington branch, and the passengers transferred from one train to the other without inconvenience. The curvatures and grades on our line being so moderate, there need be no difficulty in running the trains in time for the Baltimore and Washington trains, and by a judicious arrangement between the two companies, there ought not to be any detention, at the depot, of the passengers travelling on your line in either direction, as your road intersects the Washington road at a point equi-distant, *in time*, from Baltimore and Washington; and the interests of both companies would be consulted by establishing a depot, for mutual use, at the point of junction.

Leaving the Washington branch road, our line follows the general direction of the Patuxent valley, and crosses Chandler's run in the first mile, which stream, as has been already stated, it is proposed to pass with a trestle bridge. This species of bridge is recommended for its cheapness and not for its intrinsic merit, as it is the most common and least durable that could be adopted. It is liable to rapid decay, and repairs would be difficult and expensive. If the resources of the company would justify the expense, I would urge in the strongest manner to substitute Col. Long's plan of wooden bridge with stone piers, of 100 feet span, or some other kind of truss bridge; and of greater span, if it should be thought proper to diminish the number of piers by increasing the extent of the span. It is proposed in all cases to cover the timbers with tar to protect them from the weather, and to

saturate them with a solution of corrosive sublimate, to preserve them from the dry rot.

After crossing Chandler's run the line occupies highly favorable ground to the end of the third mile, where rock is for the first time encountered.— It shows itself in a very narrow ridge which appears to be the outcrop of a conglomerate of pebbles united by a ferruginous cement, forming the substratum of the country. On the fourth mile we cross both branches of Rogue's Harbor, which will require two culverts and a heavy embankment. This brings the line near a school house on the county road in the vicinity of Disney's and Miller's. On the fifth mile we pass Miller's house and cross another branch of Rogue's Harbor, and the county road. As the embankment is high and a culvert is required to pass the water, it will be proper to make it sufficiently high to span the road also. The sixth mile passes near to Watts' Tavern, where a deep cut must be made through a narrow sand ridge. Here for the first time we strike upon the drainage of the Severn, having crossed the dividing ridge between it and the Patuxent, which is here very narrow, the streams in fact interlocking, and our line occupying very nearly its crest. The seventh mile carries us past Sappington's to the deep cut, which lies principally in the next mile. It is not improbable that this cut may develope the presence of rock, although there is none to be seen near the surface, and if such should be the case the grade may be increased in order to diminish the amount of excavation, and of course the slopes would also be reduced and approach nearly to the vertical. The eighth mile, as has been already observed, passes through a deep cut, the heaviest work on this division. The greatest depth of cutting is twenty feet, and the amount of excavation 46000 cubic yards. The ninth mile passes through the farm and near the house of Rezin Hammond, and crosses Jay's branch, a tributary to the Severn. Some rock excavation may be expected on this section, but not more than will be wanted for the culverts over Jays' branch. Five eighths of the next mile completes the first division, extending 9 5-8 miles, and ending on Dorsey's farm. The total cost of graduation and masonry on this portion of the work is estimated at $75,812,33. Some changes might be made, with a view to economy, both in grades and trace; but those alterations would lessen the efficiency of the roads, and although indicated on the profile and map, they are not recommended for adoption.

### SECOND DIVISION.

This division commences at 9 5-8 miles from the Washington branch. The first section of this division is very heavy, giving a total of 98,645 cubic yards of excavation, and 131,808 cubic yards of embankment. The average haul for the greatest embankment will be but little short of half a mile. The other hauls will be short. In the cutting of the second ridge on the first half mile, it is possible that rock may be encountered; but this opinion is based on the peculiar shape of the hill, and not on the actual appearance of stone. The nature of the country, below this locality in our line, forbids the idea of finding rock in our excavations. The ground is much cut up by deep ravines, as the profiles show, and no stone has been found in any of those ravines. The length of this heavy section is 2 1-4 miles and it terminates near the Primary school house, in the vicinity of the Sun Tavern and Post Office. This is, with one exception, the most expensive section on the whole line: it will be seen that the embankment exceeds the excavation by 36,000 cubic yards; but this will enable us to improve the bed of the road-way, on the high grade of 40 feet to the mile, by widening it and increasing the size of the ditches to carry off the water

with facility, and thus to preserve the road bed from injury by washing.—I fear the nature of the ground is such as will lead to difficulties on this division in very rainy seasons, in preserving the slopes of the cuts and embankments, and the road-way from injury. Great care must be taken with this portion of the work, and the slopes [in relation to the horizontal] should be as small as possible. The ditches should be wide and shallow, else I fear they will gulley very soon. If the ditches were well paved with, and the sleepers well bedded in, beton, it would probably prevent any of those bad consequences. The earth over the whole of this division is easily removed; but the cost of repairs, for one or two years after its completion, will probably be considerable. The next section, one mile long is very easy. The ravines on this division are crossed near their heads, which renders but few culverts necessary. I propose to throw in stone, if it can be found conveniently, at the base of the embankments, forming something like French drains, to enable the water to percolate through; this, I think, will be amply sufficient in most cases where there are no springs. The areas of the ravines above the embankment are generally small, and no great quantity of rain can ever fall in them, and the water from the higher ground may be prevented from flowing into them by ditches which will convey it off under the road bed.

The next section is, for its length, the most expensive on the whole line. But it is believed that a change may be made on this part of the location to great advantage, by which the expense will be considerably diminished without injury to the efficiency of the road. The proposed alteration is indicated on the map; but it would be advisable before these suggestions are adopted, or the contracts let, to revise carefully this portion of the line.—On this section there are 115,200 cubic yards of embankment and 112,000 cubic yards of excavation. The difference may be taken as heretofore recommended, from the road bed, but a good deal of the cutting cannot be used for the filling, as the hauling would be too long to render it advisable to use it for that purpose. The length of this section is 2 1-8 miles.

The ravines on the first section of the 2d division drain into South river, but the dividing ridge between South Severn Rivers is very narrow, in some places not more than two rods wide, and our line is compelled to conform very nearly to the crest of this ridge, or otherwise encounter the deep and broad gulfs which are formed by the washing of the rains. A peculiarity of these ravines is that they become very deep, varying from 75 to 100 feet in depth, in a short distance from their heads.

This division terminates a short distance beyond the 15th mile, directly opposite to Leonard Iglehart's house. It is nearly 5 1-4 miles long, and is estimated to cost $120,737.

### THE THIRD DIVISION:

Commences near Iglehart's, and terminates on the lot of Mr. Brewer, near a blacksmith's shop, on the upper part of West street, in Annapolis. The line was continued down Gloucester street, to the mouth of the Spa creek, near the residence of the late Charles Carroll. Vessels drawing eleven feet water, may pass the bar on this creek. The line curves through the church grounds close to the building. This is of course objectionable, and can only be avoided by adopting some other termination, if it be deemed advisable to continue the road to tide-water. There are several points at which the road may terminate with nearly equal advantage to business and convenience of passengers. But I have thought it best not to submit any estimate, for the continuation of the road beyond Mr. Brewer's lot, which furnishes a good position for a company depot and machine

shop. But, before the contracts are let, it will be necessary for the Board to fix the terminus of the road, as the location of the depot must depend on that decision.

A line was also run from the neighborhood of the three mile oak, to Spa creek, in the vicinity of Mr. James Murray's. This route and the profile of the ground are given. The Board will be able to decide if this line be a judicious one or not. As this is a question involving the local interests of Annapolis, and the injury to private property in the vicinity, it would be improper for me to offer any opinion on the subject; more especially as the Directors are far more competent than myself to decide such matters.

The two routes, so far as the engineer may regard them, are nearly equal; but the termination of a public improvement is generally dependant on other considerations.

The extra filling in the vicinity of the negro hut on Dorsey's farm will enable us to widen our road bed. It was at one time contemplated to bridge over College creek, but it appears that the cutting in the neighborhood will be sufficient to form a permanent embankment, with a culvert over the stream, to pass the water, without any additional cost. By carrying the line a little more towards College creek, there would be less injury done to Judge Brewer's orchard, and the quantity of work at the same time would be slightly diminished.

The greater portion of this division is decidedly favorable, and the approach to Annapolis peculiarly fine.

There is but a single change on this division suggested, and that is an additional curve, of at least one mile radius, near Nicholas' on Robert Welch's farm. It would have the effect of shortening our line, avoiding the public road, and obtaining rather more favorable ground. The length of this division is 4 5-8 miles, making the whole road 19 3-4 miles in length. It is estimated that the graduation and masonry on this division will cost $37,116 33.

On a careful review of the whole line, I feel myself authorised in congratulating the friends of this project on the favorable character of the location, and the advantages its completion is calculated to confer upon the city of Annapolis, and the State of Maryland.

RECAPITULATION.

*Cost of Graduation and Masonry.*

| | |
|---|---|
| 1st. Division, | $75,812 33 |
| 2d. Division, | 120,737 52 |
| 3d. Division, | 37,116 33 |
| Total, | 233,666 18 |
| Superstructure, bar rail, | 70,000 00 |
| | 302,666 18 |
| For contingencies, superintendence, &c. 10 per cent, | 30,366 79 |
| Total, | 334,032 97 |
| For an edge rail, of 30 lbs. to the yard: | |
| For graduation and masonry, as above, | $233,666 18 |
| Superstructure, | 96,400 00 |
| | 330,066 18 |
| Add 10 per cent, as above, | 33,006 61 |
| Total, | 363,072 79 |

(To be continued.)

**SPECIFICATION OF A PATENT FOR IMPARTING TO ARTICLES OF IRON AND STEEL AN INCREASE OF STRENGTH. GRANTED TO WALTER R. JOHNSON, CITY OF PHILADELPHIA, JUNE 30, 1838. ANTEDATED DECEMBER 30, 1837.**

To all to whom these presents shall come: Be it known, that I, Walter R. Johnson, of the city of Philadelphia, in the state of Pennsylvania, have invented a new and useful improvement in the manufacture of wrought or malleable iron and steel, and of articles formed thereof; being the imparting to said materials of an increase of strength, by means of a process which I call thermo-tension, and that the following is a full and exact description of carrying into effect my said improvement.

The said process is founded on the principle that the strength of said materials is increased by means of mechanical stretching, or straining, at a high temperature.

I perform the said process in the following manner: I first determine in the usual manner, by trial and calculation, what strain might, at the ordinary temperature of the air, and before my improvement has been applied to it, be sufficient to break the particular piece of metal, or manufactured article, intended to be improved by the process of thermo-tension.

I then, by means of any suitable apparatus for applying heat and measuring temperature, subject the piece or article to be strengthened, to a temperature not exceeding seven hundred degrees Fahrenheit, preferring that of five hundred and fifty degrees for most kinds of iron, not restricting myself, however, to the same temperature for all kinds of iron and steel, but varying to a higher or lower temperature, according as the same shall be found most serviceable for the particular kind which is undergoing the process.

When the proper temperature has been attained, I apply, by means of any suitable apparatus for applying and measuring mechanical strain, a force equal, or nearly so, to the calculated strength of the specimen or article under process, and continue to apply the same as long as the metal continues to be stretched by it.

I contemplate the application of the improvement and process above described, herein called the process of thermo-tension, to the metals, wrought or malleable iron and steel of whatever form in which an increase of direct cohesion may be found useful, whether the same have been manufactured by rolling, hammering, drawing, or by any other process, as I do not confine my improvement to any particular form of materials, or of articles manufactured therefrom.

What I claim as my improvement in the art of manufacturing iron and steel, and of articles formed therefrom, is the submitting of them, while at high temperature, to mechanical stretching, or straining, as above specified, for the useful purpose of increasing their direct cohesion, by whatever means the necessary force shall be applied, and measured, or the requisite temperature communicated and regulated.

WALTER R. JOHNSON.

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TREMENDOUS POWER.—A locomotive engine built at Lowell, for the Western Railroad, on Thursday, started from a state of rest a train of sixty-three cars, filled with merchandise, weighing *three hundred and thirty-three tons*, of 2000 lbs., and carried it with ease over an ascent of 10 feet to the mile at the rate of nine miles an hour!

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

No. 5, Vol. III. New Series. | SEPTEMBER 1, 1839. | Whole No. 346. Vol. IX.

## ELECTRO MAGNETISM AS A MOTIVE POWER.

(Continued from page 100.)

From the preceeding remarks it will be seen that we are of the opinion, that further improvement in the electro magnetic engine depends not so much upon any one grand invention, as upon a thousand minor and apparently unimportant alterations. We are aware that this is contrary to the general opinion, but in justification of ourselves, we point to the history of the steam engine, the printing press, the Jacquard loom, cotton machinery, and in fact, of any important engine at present in use. It is true that some ingenious man may make a single great and valuable improvement, but we have no idea that any particular form of wheel, or disposition of magnets (*where there is no change in the principle of action*) is to prevail to the exclusion of every other one. It is true that a second Watt may do for this, what the first did for the steam engine, but it must be a man who, like Watt, knew well the principles with which he had to deal, and who could lay out in the workshop of his fertile brain, employment for the hands of a thousand ingenious mechanics.

Popular prejudice has done much to retard real improvement in this matter, by attaching undue importance to the mere construction of models or machines. By most persons, the inventors of different engines are looked upon as the founders of the science of electro magnetism, and this opinion, sanctioned by the language of the daily press, has raised to high fame the name of mere constructors of any one of the thousand mechanical applications of the principles pointed out and brought to notice by Ampère Faraday, Henry, Daniels, and a host of others, whose names are almost never thought of in connection with this subject.

It is only by a constant reference to these first principles, that any further progress can be made. Any disposition of parts however complicated, which only perpetuates and magnifies the errors and faults of preceding

machines, may serve to blind and impose upon the ignorant or careless observer, but can never bear the tests which have been proposed, and must therefore be condemned by all prudent and intelligent men.

The best guarantee we can have of the success of electro magnetic machinery, is to find it taken up by men of science, wealth and practical skill, and although it is not often found that these important requisites are united in one person, a very fair equivalent is to be found in a number of persons, each one excelling in some one of the three particulars. Since we have commenced writing these remarks, we have understood that such has already been the case and that we shall soon see what science, wealth, and skill united, can accomplish.

Perhaps we can no where, better than in this place, touch upon a subject of rather delicate nature, but bearing a most important relation to the matter in hand—and which, since we have professed to speak freely, we are bound in candor, to notice. We refer to the articles which from time to time appear in our various journals of professed scientific character, upon the subject of electro magnetism.

We consider it *unfair*, to say the least, that a novice in science should arrogate to himself, directly or indirectly, the credit of what has been done before, and perhaps in a better manner, without in the slightest manner alluding to, or crediting the labors of others. This either involves a wilful concealment of the writers knowledge of what has been done before, or an ignorance of the state of the science. Charitably presuming that the latter is the case, all papers, treating us with a re-discovery of important facts and principles in science, should be accompanied by a statement of the case. and correction of the writer's (supposed) misapprehension.

The effect of the continual re-announcement of discoveries of this character, is to create an idea that an extreme ignorance prevails upon this subject, and the result is, that our labors in this field are unfairly treated abroad, and the just and well merited sarcasm bestowed upon quackery in science, is visited upon our whole scientific community. That this evil prevails in all branches of science, we do not deny, but that electricity, galvanism and magnetism, has been dragged into the service of *humbug* in an unprecedented degree, no one can doubt. The most absurd doctrines are broached, and aided by the ignorance and impudence of persons accidentally endowed with some influence in their own circle, the world is nauseated by enormous doses of humbug and absurdity. We need not particularise, but it is well known that the wholesale endorsement of an entire system of evident nonsense by many public men, and well known characters of scientific? reputation, has created in Europe, a most contemptible opinion of science in this country.

To remedy these evils of no small magnitude indeed, there must first be diffused a more general knowledge of these subjects, which are in fact well adapted to popular comprehension, and for this very reason, the more frequently seized upon by quacks. It would be of incalculable benefit to the

community, if those of our own distinguished philosophers, who have done so much for the advancement of the science of electricity and its various ramifications, would in a popular but carefully prepared treatise on this subject, give to the large portion of our people interested in such matters, the results at which they, and the irbrethren in Europe have arrived. Even our colleges have no good American text book for these branches of science, and nothing of a more popular character is to be found.

From the good effect of a few judicious lectures, we are inclined to think that very much might be done by way of oral instruction and actual illustration from models and apparatus.

Another difficulty is to be found in the indifference, with which many men of talent and theoretical knowledge, are disposed to regard any mechanical application of electro magnetism. Is it not their duty to encourage and direct proper experiment? Can they in any way do more good or apply their own knowledge to better purpose? We are firmly convinced, that men of science can do much in this way, and were they to take the field, quacks would soon leave it.

Having already occupied more of the time of our readers than we had intended, we shall conclude with but a few remarks as to the capabilities of the electro magnetic engine in its improved form. Its chief and peculiar advantage is, that the cost of maintaining it in action, commences and ceases almost instantaneously with the action itself. Unlike animal power, it has to be fed only while it works, and days, weeks and months of inaction involve no other expense than the interest on the cost of the machine. Unlike the steam engine, it needs no time for "firing up"—at a moment's notice it can be brought into full action. The second advantage, consists in its freedom from all danger, for though the same *quantity* of electricity, with greater *intensity*, could give a shock equal to a bolt of lightning, yet as used in the electro magnetic machine, no sort of danger whatever is to be apprehended; neither explosion nor fire can possibly take place. Its freedom from danger and its capability of directly obtaining high velocities, are excellent qualifications for its adaptation to cotton, wollen and silk machinery. No agent is better calculated to supply the place of the hands of man, and where no great power is required, even a small model may answer a very good purpose, and many items of domestic labor could be performed most admirably by such a machine. In our large hotels an electro magnetic engine would be of great service, to raise water, brush shoes, clean knives, raise baggage, &c., would alone be a profitable mode of application.

There can be no doubt that as power is gained, this agent will be on a par with steam, and of course, applicable to all purposes with equal if not greater advantage. But there is one use of electro magnetic machinery, which even in its present rude and unimproved form, is worthy of attention. We refer to domestic manufacture, which is destined to become, ere long, a peculiarity of our nation.

The cultivation of the beet root and mulbery, must inevitably lead to the home manufacture of sugar and silk, and the machinery necessary for both purposes, is capable of great simplification and well calculated for the employment of the females and children of an household, assisted by the power of the engine under consideration. We consider that this view of the subject alone, has a remarkable bearing upon our political economy, and is deserving of further notice. Our object, in the remarks we have hastily thrown together, has been to direct attention to an important subject, and if this end is accomplished, we shall be amply rewarded.

Before concluding, we must again remark that we have spoken in general terms with a single exception, having had no reference to any individual, and must therefore be free from the imputation of being influenced by personal prejudice. If the remarks are capable of application, that remains for individual judgment, we have intended no more than a general view of the subject.

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American Locomotive Engines in England.—By the following extract from a Philadelphia paper, it will be seen that our mechaincs have again been complimented by an order from England for locomotive engines. They are ordered from Messrs. Baldwin, Vail and Hufty, whose engines have, under the original firm of M. W. Baldwin & Co., attained so high a celebrity.

When we first began to point out the superiority of American locomotives, we had much prejudice to contend with, and while the accounts of various performances was doubted and even sneered at abroad, the feeling in favor of imported engines was yet strong in this country. Now the tables are turned, and we are sending engines to England.

We shall endeavor to obtain from Messrs. B. V. & H., the particulars of their order and present it to our readers, the mere announcement cannot fail to prove highly flattering, not only to these gentlemen, but to American mechanics in general.

We are informed that Messrs. Baldwin, Vail & Hufty have received by the Great Western, applications from the extensive railroad companies in England, for a supply of locomotive engines. This fact speaks volumes, and is the more gratifying from the fact that the gentlemen of that firm have never taken a single step towards introducing their engines in that country, in any way whatever. The application is the result of the high character their engines have acquired for their superiority and efficiency, in this country. We have no doubt but Messrs. Baldwin, Vail & Hufty will sustain their well earned reputation, and have nothing to fear from a fair competition with the manufacturers of old England.

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At Stephenson, Rock Island county, Illinois, on the 22nd of August, in the 30th year of his age, Mr. Amidee Blanc, chief engineer of the Rock River improvements.

It is with emotions of deep regret, that we hear that our friend Mr. Blanc is no more. He had quite recently returned from Europe, laden

with useful information, derived from his own observation and the best published authority, and was about to re-commence upon his duties as chief engineer of the Rock River improvement, for which he had thoroughly prepared himself by the inspection of the most approved French works—when he was thus suddenly cut off.

During his professional career, his services rendered to the New York and Erie railroad company, had rendered him known to many who will regret his premature loss. To a sound and discriminating sense in the field, Mr. B. added an uncommon neatness and accuracy in his closet work. His maps and drawings have always been beautiful and exact. During his visit to Europe he made original drawings of many new, and to us unknown works, and it is a source of regret, that so much valuable information should be lost to the country.

To those who knew Mr. Blanc in private life, the loss is indeed a great one. He was characterised by an uncommon modesty, amiability and suavity of disposition, which won the hearts of all with whom he was associated.

We mourn over the loss of a valuable member of the profession, and still more, over the departure of an honest man and a kind friend.

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MEMOIR OF LIEUTENANT COLONEL B. AYCRIGG ON THE SUBJECT OF THE LIGHT HOUSES AT BARFLEUR AND OSTEND.

February 13, 1839. Mr. Cushman, from the Committee on Commerce, reported the following resolution; which was read, and agreed to by the House:

*Resolved,* That a detailed report and drawings of the light-houses at Barfleur and Ostend, prepared by Lieutenant Colonel B. Aycrigg, one of the chief engineers on the State works of Pennsylvania, be printed for the use of the House.

*Memoir on the subject of the light house at Barfleur, and also the light house at Ostend, by Lieutenant Colonel B. Aycrigg, A. B., one of the chief engineers on the State works of Pennsylvania.*

The following detailed accounts of the light house at Barfleur, on the northwestern coast of France, and also of that at Ostend, on the coast of Belgium, have been prepared with much care from notes taken on the ground, in the summer of 1837, and now are respectfully presented to Congress, in compliance with the request of one of the members, who is desirous of seeing the improvements introduced into our own system.

To fulfil the promise that the description should be furnished, it was found necessary to make a journey to the light at Barfleur, expressly for the purpose; since the plans could not be obtained in the metropolis, in consequence of the absence of the possessor.

In order that there may be no delay on the grounds of want of information, there has been much time and labor bestowed in reducing the measures from those that were taken to their equivalents, measured from two lines of reference, the one vertical, the other horizontal, passing through the centre of the light. The notes, having been thus much simplified by calculation, will be readily understood in all the details by any one familiar with mechanics, and, consequently, any engineer or other mechanical officer might immediately take charge of the construction of a light-house that

will, in all respects, be essentially the same as that at Barfleur or at Ostend, and, with respect to the peculiarities of the former, agree in the minute details.

Should this communication be the means of introducing the lenticular system into our light houses, the writer will feel himself amply compensated for his trouble, by the reflection that he has been the channel through whom an improvement has been brought to our shores, that may preserve the lives of many a warm hearted mariner or useful citizen on his return to his native land; be useful to the commercial world, gratifying to the philanthropist, and leave little more to be expected, unless chemistry should furnish us at some future day with a substitute for the lamp, that might by its superior brilliancy, penetrate farther into the fog and mist. Even in that case, a better arrangement than the revolving lens could not be made for the purpose of disposing of the light after it is produced.

The details will be given at length in the latter part of this communication. But as these may be uninteresting to many who would wish to have a general knowledge of the arrangement, without the necessity of going over a long list of measures, and perhaps in the end have but little satisfaction, unless somewhat accustomed to mechanics, the following familiar description is given, to supersede the necessity of an examination of the minutiæ.

The lamp has four concentric wicks, the largest having a diameter of 3 1-2 inches. They are raised on cylinders separated, that the air may pass between, and so far above the body of the lamp as not to have the light intercepted in its passage to the lower mirror. These four wicks produce a flame six inches high. The oil is supplied in excess by small pumps worked by machinery in the interior of the lamp, wound up in the same manner as a watch. [This is very common in France.] This lamp, being placed in the centre, is surrounded by 16 lenses, in oblong frames, 34 inches high and 14 1-2 inches wide, standing side by side on one ring, and steadied by another laid on top and screwed fast to the frames: thus forming a hollow cylinder of glass, or rather a 16-sided prism of about 6 feet diameter, and 2 feet 10 inches high around the lamp. Each lens is composed of several separate pieces of glass, the centre piece being a perfect plano-convex lens, having the flat side towards the light. The other pieces are portions of circular prisms concentric with the lens, the back coinciding with the plane surface of the middle lens, and the salient angle towards the centre of the frame. In this manner nearly the same effect is produced as from a lens the entire size of all these pieces taken together; while, being comparatively thin, they are much lighter in use, and at the same time much less difficult, and consequently less expensive in construction.

From the measured convexity of the centre lens and the circular segments, it appears that they are all described from the same centre, midway between the light and the curved surface of the middle lens, and consequently that they have taken the ratio of refraction at 2-3, or the average for crown glass, and have neglected the spherical aberration. This difficulty in single glasses is unavoidable, but can easily be obviated in a compound lens. But, as the laws of optics must necessarily be followed in all future works, it would be lost time to go into an investigation of the proper radii for these segments, since they would be inapplicable with a glass having a different refracting power; and this can only be ascertained by experiment on the material to be used.

The backs of all these pieces of glass being in the same plane, a vertical cross-section through the centre would show a straight line on the side towards the light, and a serrated edge on the opposite, having the salient angles about 1 1-8 inch in advance of the re-enterings.

These 16 lenses being thus secured between two rings, the one above and the other below, the lower ring is supported on 8 bars that curve out around the lower mirrors, and then, curving in again to another ring of the size of the former, and below the mirrors, are carried as diagonals, and terminate on a cog-wheel 26 inches diameter, lying horizontally around the shaft; and supported on 6 wheels that roll around on a shoulder of the shaft, when the clock machinery, set in motion by a weight of 300 pounds, acts upon the cog-wheel around the shaft, and thus every 8 minutes causes one revolution of this wheel, together with the diagonals, uprights, and rings that carry the lenses. The whole is kept central by horizontal friction rollers acting on the outside of the shoulder, below the small wheels. The whole of the moving part is poised upon these small wheels below, and has no other support.

These 16 lenses, thus concentrating the light into as many radii projecting from the lantern, might be compared to a revolving capstan with its arms. Each revolution being completed in 8 minutes, the observer sees one of the radii every half minute.

Inside of this revolving circle of lenses is placed a stationary frame to support the mirrors, leaving one inch play between them. The shape of this interior frame is not unlike a large parrot-cage with an eliptical top, while the lamp would represent the perch in the centre. This is firmly secured to the shaft, the moving frame carrying the lenses being supported on a shoulder below, and the shaft itself secured in an opening in the centre of the stone floor below. Upon this frame is supported a platform at 4 feet below the lamp, and upon this platform the keeper stands when cleaning the glasses or attending the lamp. To get into this interior space, he takes the opportunity when the revoling bars that carry the lenses coincide with the fixed bars that support the mirrors, and enters on the land side below the lenses; the mirrors on that side, both above and below, being omitted, and their place supplied by a reflector near the lamp, to throw this part of the light towards the channel.

To this interior frame are attached two rings of strong wire for each row of mirrors, the one being inside and the other outside of the upright bars; upon these rings the mirrors rest, and are brought to the proper angle by adjusting screws, so as to throw the light in the direction of the horizon.

There are 28 of these mirrors in a circle; the four on the land side between two of the bars being left out. There are four circles below the lenses and seven circles above. Those that are above do not come in the way of any thing connected with the revolving part of the work, but those below extending the same distance with those above, or 4 3-4 inches beyond the outer range of the lenses; the bars supporting the lenses are curved out as before mentioned, in order not to touch when moving around outside of the mirrors. The space between the two is one inch, and there is also an inch clear between the bars and the floor outside, on a level with the bottom of the window.

Immediately below the part described is the sleeping chamber of the keeper; a portion of the interior cylinder having been removed, after the column was completed, for the purpose of making room. A stove-pipe from this place passes up on the land side and comes out at the roof.

In this apartment he rests without apprehension, although near the top of the column, and more than 200 feet above the ground, or rather the rocks, swayed by the blast, as the tall shaft springs to the unobstructed force of the wind, sufficient at times, as the keeper asserted, to throw him forward while leaning carelessly against the window, and quite perceptible

during the visit of the writer; the wind roaring loudly around the lantern although at the surface there appeared nothing more than a strong sailing breeze. Still the column has sustained the most violent storms without the least mark of weakness; and this motion arises, not from a tottering of the fabric, but from the elasticity of the material, although that material be granite.

A description of the building has been printed in pamphlet form, but not being at hand at present, and but few notes having been taken respecting the parts contained in the printed account, the writer cannot enter into this subject; nor is it important for the present, since the form and construction of the building depended upon the particular locality, while the application of the light may be universal.

It will readily be seen that a light of this description cannot be used in a combustible building; for should the keeper neglect to put down the curtains in the morning or evening, when the sun is near the horizon, these powerful burning-glasses would, inevitably, produce a conflagration.

The writer observed, both at Barfleur and at Ostend, that several of the mirrors were materially injured by the sea air tarnishing the silvering, although the backs and sides were covered by a sheet of brass turned up around the edges. This difficulty might be removed by previously giving the backs an air-tight coating of varnish.

Another object to be attended to in such constructions is to keep the window-glass perfect in the range of the principal light. A defect, in this respect, was pointed out by the keeper at Ostend, as the glasses meet on the horizontal line; and although merely laid together without any thing between, still a part of the light is lost, that would not have been as great had the joint been above or below.

To the stranger who visits the Barfleur light, this assemblage of 308 mirrors and 16 large lenses, surrounded by 16 windows of plate glass, more than ten feet high, all polished to the highest degree of perfection, and all concentrated within the small compass of the lantern, presents one of the most brilliant exhibitions that the arts can furnish, especially when in addition to this, he feels the effect of standing 236 feet above the level of the ocean, without anything to prevent his falling out; for the plate glass of the windows is scarcely perceptible, although so strong that the largest sea birds cannot break it, but frequently fall dead by the blow when, flying towards the light, they come with full force against the glass. The stranger on entering from the darkness below, is taken by surprise, and for a while, afraid to move, lest he may touch on one side or the other, and the apparently frail fabric crumble under his hands!

(To be continued.)

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Profits of Railroads.—It is a remarkable fact that almost every railroad, whether in this country or in Europe, after its construction has been found to pay more than was originally estimated. The Boston Centinel of last Saturday says:

Wednesday last completed a year, since the opening of the railroad from Salem to Boston---and during that time two hundred and eighty thousand paying passengers have gone over the road—two and a half times the number originally estimated. The freight cars were not started till after the passenger cars had been in operation some months. Their earnings will afford a nett profit of ten thousand dollars a year.

**THE FIRST ANNUAL REPORT OF THE DIRECTORS OF THE ANNAPOLIS AND ELK RIDGE RAILROAD COMPANY.**

(Continued from page 128.)

From all the consideration I have been able to give the subject, I can entertain no doubt that this road will yield a fair return of revenue on its cost. The probability is, that in consequence of the improvements now making to facilitate intercourse between the north and the south, Norfolk will become the point to which nearly all the travel, to and from these great sections of the Union, will concentrate; and that an entire inland communication, by which the dangers of the sea may be avoided, will be established between Charleston and New York. When this is the case, passengers going north will have the choice, on arriving at Norfolk, to proceed in steamboats, either for the Eastern Shore railroad, or Baltimore. When the navigation of the Potomac and Patapsco is closed they will be compelled, except at great expense and peril, to resort to the Eastern Shore railroad, unless the Annapolis and Elk Ridge railroad should be constructed, in which event, those that prefer it will land at Annapolis and thence proceed to Baltimore or Washington, as business or pleasure may dictate. The city of Baltimore would find it a serious evil, to be thrown out of the great thoroughfare of travel and trafic between the north and south; and she most assuredly will be so thrown out, at all times when the Patapsco is closed with ice, unless other means of communication than those now existing are opened. The influence which such a state of things is calculated to exert upon her trade, must be perfectly obvious; as the Southern merchant, if he found Baltimore difficult of access, would at once proceed directly to Philadelphia or New York by other and more easy communications. These evils may, however, be corrected by the construction of the Annapolis and Elk-Ridge railway; and Baltimore may derive, in various ways, as much benefit from this short road, in proportion to its extent and cost, as from her own bold and magnificent works. For, independently of its direct advantage to that city, it will prove a valuable auxiliary to her railroads, by drawing to them a considerable amount of business which, under other circumstances, would find some different channel.

It is in this way that a *system* of internal improvements may yield a handsome revenue, while some of the minor and independent works are regarded as unproductive, at the very time that they act as important tributaries to the main trunks, by adding largely to their revenues. Thus in New York, the Erie Canal is the great thoroughfare and common recipient of the smaller works; and although the lateral canals may not be productive, when the receipts derived directly from them are alone taken into view, yet there can be no question, that when regarded, as they should be, as portions of a common system, they contribute in no small degree to the success of the more important works; and such, it is believed, will be the relation in which the road under consideration will stand towards the great public improvements in the State of Maryland. There can be but little doubt that the travel on this route will be considerable at all times, especially during the sessions of the legislature and of the courts. It has been observed as a general rule, that travel always greatly increases when a railroad is opened, and it is not believed that this work is destined to prove the exception. It has also been found that railways obtain a decided preference over all other means of communication, and there is not, perhaps, a stronger instance of the truth of this proposition than is furnished by the Baltimore and Philadelphia railroads, which, when first projected, were ridiculed as chimerical; but no sooner were they opened for travel, than a large proportion of all the passengers were found to prefer that

route to the steamboat line; and it may be laid down as an universal rule, sanctioned by all experience, that the means by which the passengers may be transported from one given point to another, *in the least time*, will always receive the principal part of the public patronage. The time of travel between Annapolis and Baltimore by steamboat, is about three hours. By the railway, it may be something less than two. The establishment of a Naval Academy or Naval Station at Annapolis, would add much to the travel and transportation on this road.

Another source of revenue will be found in the Patuxent granite quarries, near the Savage Factory, which can no where find so convenient an outlet as Annapolis affords. Besides this, great facilities would be found in obtaining cheap and extensive yards for dressing the stone previously to shipping it for market, and the price of subsistence for workmen would be less than in larger cities. The stone from these quarries, I understand, is of an excellent quality; and the granite trade has already become a very important branch of domestic commerce.

A great deal of wood, still growing in the neighborhood of our line, would be sent to market if the road were completed; as would also charcoal, and many domestic articles which do not bear the cost of transportation under existing circumstances.

It is particularly recommended to the company, to reduce as low as possible the cost of transportation on *lime*, in order that it may be used extensively in the adjacent country for agricultural purposes. This policy will operate directly by adding immediately to your receipts, and in the course of time, as the country improves in population and resources, by constantly increasing your revenue. By these means you would not only consult the interests of the stockholders, but would add materially to the wealth, population and general convenience of Anne Arundel and Prince George's counties, and indirectly to other portions of the State.

As this road will render Annapolis an outer or winter harbor for Baltimore, it is probable that a large quantity of merchandize, owned in the latter city, will be annually imported at Annapolis, and pass over this road to its destination, thus adding to the revenues of your company.

The transportation of ore, fuel and supplies to, and of iron from, the Patuxent furnace will also contribute to your dividends, and they will be yet further increased by a good deal of travel, and transportation of tobacco and other agricultural productions, from Prince George's. The branch road of 1 1-4 miles, shown on the map, would terminate at the furnace, and would no doubt amply repay the stockholders for their investment. This branch may be made for about $8,000, or less as there is no heavy work in it of any description, and indeed the principal cost will be in the laying of the rails.

The daily mails to and from Annapolis will of course be carried on this road, and will increase your receipts.

Another source of revenue will be found in the coal trade from the Chesapeake and Ohio Canal. This cannot, perhaps, be relied on with certainty, except in case of severe winters. But as a general rule, whenever the navigation at the north is closed, it is likely that a large quantity of coal will be transported from the District of Columbia by railroad to Annapolis, and thence shipped to market. The Cumberland coal ought not, under ordinary circumstances, to cost over $5.00 per ton, including all reasonable expenses for transportation to New York or even to Boston; yet that species of fuel is seldom less in those cities, during a tolerably hard winter, than $13,00 per chaldron of 36 bushels, the ton being 30 bushels. Of course this article would well justify the expense of transportation on rail-

roads from the District of Columbia, under these circumstances; and it is indeed probable that every winter more or less would be shipped from Annapolis, the quantity depending on the price of the article in New York.

Looking to these various sources of revenue I can entertain no doubt that this road, considering the comparatively cheap cost at which it may be made, will yield a fair return in dividends for the money invested in its construction.

But he who would measure the utility of a public work by its revenue alone, would take but a narrow and most illiberal view of the subject. No man can estimate with tolerable precision the advantages which result from a judicious system of internal improvements; for the benefits they confer on the community are so ramified, complex, and widely diffused, and in some instances so silent in their operation, that it is almost impossible fully to appreciate them. The statesman and the political economist justly regard them as the powerful instruments by which the condition of mankind has been ameliorated, the natural resources of the world developed, and distant nations, formerly separated by jealous rivalry, are united in the bonds of common interest. The internal improvements of Pennsylvania have cost nearly $23,000,000, and it has been estimated that the increased value of property, in consequence of those improvements, exceeds $100,000,000. Notwithstanding the internal improvements in that State are incomplete, and many of its works imperfect, it is a most triumphant fact, that during 1837, a season of most unusual depression in business, the receipts from that system of public works exceeded $1,600,000 or 7 per cent. on the whole cost. The nett dividend, after paying all expenses, was something over 5 per cent., and it is supposed that for the present year it will exceed six per cent. As her loan is a five per cent stock, she may be regarded as already out of debt, and likely to fill her coffers, thus relieving her citizens from taxation with the fruits of her responsibility and public spirit. Yet who can pretend to calculate the value of the advantages which that State has derived, and is likely to derive, from her domestic policy, in her increased population, agricultural and mechanical productions, in the discovery and working of her mines, and in bringing her waste and unproductive lands into cultivation? "It has," says a committee of the Pennsylvania Legislature, "raised up in our former uninhabited districts an intelligent and permanent population; and converted the mountains into theatres of busy life, and our hitherto waste and valueless lands into sites for flourishing and populous villages. Its benefits are not alone confined to those engaged in trade, but are becoming *general* and *universal.*"

It appears to me that the advantages likely to result to the city of Annapolis from the construction of this railroad are manifold and obvious; and that few works in this country are better designed, in proportion to cost and extent, to subserve more useful purposes. It is unnecessary for me more than to hint, in addition to what has been already said at some of the benefits, which may be anticipated from this improvement.

The natural position of Annapolis is commanding and important. Its fine and commodious harbor, seldom closed with ice, its proximity to the federal capital and the capes of Virginia, its neutral and convenient position between the north and the south,—confer on this city great advantages for commerce, and especially recommend her to the notice of the General Government as, under every view of the subject, decidedly the best locality in the United States for the site of a Naval Academy. Such an institution has long been a favorite project with the friends of the Navy, which

include all classes of citizens; and as the objection which has heretofore been urged against Annapolis on the ground of its difficult accessability in the winter, will be removed by the construction of the railroad, it is to be hoped that Congress will no longer delay yielding to the popular feeling on this interesting and important subject.

Annapolis also possesses many conveniences as a Naval station. It frequently happens that it becomes necessary to despatch an armed vessel to sea on an emergency, when it is difficult to send instructions to any of the present stations. In the winter when the water communication with Norfolk is closed, considerable delay would be experienced in getting a vessel to sea, if orders were sent to that yard by land. This is also true in relation to army movements, and it is well known that, in the winter of 1836, great difficulty and delay were encountered in transporting troops from Baltimore to Florida, whereas if this road had been made, their movements might have been greatly accelerated by embarking from Annapolis. And indeed it is well worthy of consideration whether it should not be the policy of the government to keep a large military force and stores at Fort Severn, ready to be removed, at any moment, when the exigencies of the service might require their presence elsewhere.

When the Baltimore and Ohio railroad is completed to the Ohio, Annapolis will enjoy a portion of its blessings, not only as a useful auxiliary to Baltimore, but as a direct participant in the great trade of the West. The difference by railroad being only about 20 miles, a distance of no account on so long a line. As Baltimore increases in population and wealth, the relations existing between her and Annapolis, will become more intimate and mutually dependent; and the latter will share in the prosperity of the former; and such, indeed, may be said to be the true position occupied by the different portions of the State towards its great commercial emporium, which, like the heart of the human body, elaborates the *life blood*, that in its circulation carries health, strength and energy, to the extremities of the system.

The favorable influence which the construction of this road is likely to exert on the value of the lands in its vicinity has been already adverted to; and as the mere statement of the proposition must make it perfectly apparent, it is quite unnecessary for me to enlarge further on the subject, than to observe, that the great benefits which have resulted to the agricultural interests in this State, from the investigation of Professor Ducatel, in relation to calcareous and alkaline manures, must prove a source of real congratulation to every citizen of Maryland.

I owe an apology to the Board for the mutilated and defaced appearance of the drawings, which is owing to a fire having originated in the building occupied as an office, from which they were rescued in their present condition. The same cause must explain any inaccuracies which may have crept into this report, as it has necessarily been prepared in great haste. All the materials I had collected for the report, and all that I had written previously to the fire, were entirely consumed. I have therefore omitted many details, and much that I had intended to say on several subjects connected with this improvement.

In conclusion, it affords me great pleasure to acknowledge the valuable services rendered by my principal assistant, Alexander Evans. I feel myself greatly indebted to his intelligence, skill and industry.

I have the honor to be, gentlemen, Your obedient servant,

GEO. W. HUGHES, U. S. Civil Engineer,
Chief Engineer of A. & E. Railroad.

The detailed estimates accompany this report as an appendix; and I take

the liberty of suggesting to the board that it would be improper to publish the estimates, as I believe the *prices* are higher than offers will be made to do the work for.

REPORT ON THE PROGRESS OF CONSTRUCTION OF THE ANNAPOLIS AND ELK RIDGE RAILROAD.

ENGINEER'S OFFICE,
January 1st, 1839.

*To the President and Directors of the*
*Annapolis and Elk Ridge Railroad Company.*

GENTLEMEN :—On the 6th of February 1838, my report of the 30th of January preceeding, in relation to the surveys and location of the Annapolis and Elk Ridge railway, was adopted by your Board; and I was directed to make all the necessary preparations for a speedy commencement of the construction of the work. Under this authority, I advertised for proposals to undertake the graduation and masonry, on the 20th of April following. This "letting" excited much competition among old and experienced contractors, and the Board was thus enabled, on the 29th of May, to contract for the entire work, under advantageous circumstances, for the gross sum of $158,157. Subsequently, some changes of plan and location were ordered by the Board, which added somewhat to this amount. These changes will be hereafter explained.

Previous to the "letting," there was but one change made in the old location, and that in accordance with a suggestion in my report of the 30th of January. This alteration was made at Mr. Hodges', and induced a very considerable saving of expense, besides improving the trace of the road.

After the contracts had been perfected, the Board directed me to locate a line diverging from the one already adopted, soon after crossing Chandler's run, as near to the Patuxent furnace as the nature of the ground would permit. It was conceeded on all sides that this line was inferior *in the abstract*, to the old or upper line, but the Board properly regarding it as a question of policy, were induced by the propositions and representations of the Messrs. Ellicott to adopt this new line, by which they doubtless consulted the interests of the company. This change involves an additional expense of $3,450, to be defrayed by the Messrs. Ellicott, the proprietors of the Patuxent furnace, who have in addition, given the free right of way through their own grounds, and have secured without charges to the company, the right of way through other portions of the line, making in all, perhaps, nearly one-fifth of the entire length of the road. This liberal and public spirited example, I am sorry to say, has been followed by only two other proprietors on the route,—Messrs. Nathan Warfield and William H. Baldwin, both of Brotherton. On other portions of the line, the land damages have been high, but not as extravagant as on many other similar works in the State.

The original plan adopted by the Board for crossing Chandler's run, was by a wooden Truss Bridge, 600 feet in length, on stone piers, after Col. Long's Patent "Jackson Bridge." But subsequently, on reports from a committee appointed to inspect the locality, and from the Chief Engineer, the Board in view of the superior permanency of the plan then suggested, determined to effect this crossing by a heavy earth embankment, and a stone arch of 20 feet chord to discharge the water of the creek. This change of plan involved an additional cost of $7,526 56 chargeable to the company. These are, I believe, the only deviations from the original project on the entire line. A minute description was given of

the location in my first annual report. I beg leave to refer to that document for all information that may be desired on that subject.

The actual construction of the works was commenced in June last, but was not prosecuted with much vigor till July. From that time to the present, it has progressed with as much rapidity as the means of the company would warrant. Nearly all the work of this description is already finished, leaving in fact only 200 perches *dry masonry* still to be laid. The amount of requisitions issued from this office under this head is $24,883 02, exclusive of the 20 per cent, leaving to be paid on final estimate, excluding the 20 per cent, $7,048 13.

RECAPITULATION.

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|---|---|
| Total cost of graduation, | $128,318 46 |
| " " masonry, | 33,041 50 |
| | $161,359 96 |
| Deduct amount to be paid by Messrs. Ellicott, | 3,450 00 |
| Total, | $157,909 96 |

For something closely approximating to this sum, there can be no doubt the work will be completely finished; for if any of the contractors should abandon their sections, of which I trust there is no probability, a sufficient sum will remain in the hands of the company, of the retained 20 per cent, to meet the additional cost incident to a re-letting.

In planning the work, care was taken that the slopes of the excavations and embankments should be nearly those which it was supposed the dirt would naturally assume; and experience has shown that the assumptions for the different kinds of earth were nearly or quite correct. In consequence of these precautions, and the care bestowed on their construction, the embankments though still in a green state, and notwithstanding the very unfavorable autumn and winter, have preserved their forms uncommonly well; and indeed, where they have been carried to their full height and have been properly dressed, no washes of any consequence have taken place. This is a most gratifying result, as it ensures the stability of the work, with slight repairs.

The masonry has been generally well executed. In planning the different structures, strength and durability, rather than ornament and show, were consulted; yet it is believed that the arched bridges over Rogue's harbor and Chandler's run, will not suffer in a comparison with buildings of a similar character on other works. These bridges, (and all the small culverts on the first seven sections,) with the exception of the arch at Chandler's run, which is built of granite, are constructed of a hard sandstone, which is easily quarried and readily dressed to a pattern. The two principal localities of this stone, are near Cecil's, and at Nathan Warfield's. Some of these rocks are a conglomerate of quartz pebble, united with a ferruginous cement, but they are difficult to dress, and are only fit for rough work. The stone for the lower portion of the line was brought from Jones' Falls and from Port Deposit. In consequence of the absence of sufficient stone of a proper character on the 8th section, two culverts, one of them large, were built of brick, This has added considerably to the cost of masonry, as the bricks were brought from Baltimore. It would have been cheaper if the bricks had been burnt on the ground, but for a long time I had hopes to find stone in the vicinity of a nature suitable for our purposes, but was forced at length to abandon the idea, when it was too late to burn the bricks for ourselves. The stone found on Warfield's farm may hereafter prove valuable as a building material, in consequence of its accessa-

bility, its fine texture, durability, and the convenient forms in which it may be quarried and wrought. We have on hand about 50,000 bricks, which are intended for the centre depot.

The geological formations of the country have been found to agree perfectly with the assumptions in my last annual report. In speaking of the deep cut near Sappington's, on the 4th section I remarked, that "it is not impossible that this cut may develope the presence of rock, although none is to be seen near the surface,"—this has turned out to be the fact, and considerable rock has been encountered. As it was not to be supposed that the contractor could form a very correct opinion, before commencing operations, of the formation of the country, and as his work has been taken at a low rate for ordinary graduation, I think it but just that some extra allowance should be made to him, but to what extent I have not yet the means of ascertaining. This will not, however, materially increase the cost of graduation; and there is no other case on the road where there would be any propriety in extending extra compensation.

SUPERSTRUCTURE.

In relation to the superstructure I have heretofore submitted the following report:

ENGINEER'S OFFICE OF ANNAPOLIS AND ELK RIDGE RAILROAD.
*November* 12*th*, 1838.

*To Somerville Pinckney, Esq.*
*President of Annapolis and Elk Ridge Railroad.*

SIR:—The rapid progress with which the graduation and masonry have been executed up to this date, renders it important that the Board should decide without delay, on the kind of superstructure to be used on our road, in order that arrangements may be made to procure, during the ensuing winter and spring, the materials necessary for its construction.

If there should be no suspension of operations nor any unforseen difficulties arise, the entire graduation and masonry will be completely finished early in the month of May next; and the laying of the rails should be commenced immediately thereafter, say the first day of June at the farthest. The whole track may be laid in six weeks from the time of begining, if it should be deemed important to have it finished so early; but it will probably be advisable, both as it regards the quality of the workmanship, and the economy of construction, that double that time should be devoted to it. This will bring it to the 1st of Sept. 1839, on which day the road may be opened for regular business.

One advantage in extending the time for laying the track will result from the fact that as the work progresses, the rails, mud sills and other materials, may be conveyed on the road to the places where they are wanted; thus diminishing the cost of transportation; and one party could lay all the rails in the course of three months, which would probably decrease the price of workmanship.

We omit the discussion of the various forms of superstructure and proceed with that portion of the report which treats of the plan adopted.—Eds. R. R. J.

The third or bridge rail is also an American invention and was first adopted on the Wilmington and Susquehanna road. Subsequently it has been used in a modified form, on the Great Western railroad, from London to Bristol, England, one of the most magnificent works of the kind in the world. With a given weight of metal, this is clearly the strongest form

at present used, and it is this rail I now have the honor to recommend to the Board for adoption. In order that all the arrangements for the proposed superstructure may be clearly understood by the Board, I have caused patterns, of the precise size of the different parts to be made for illustration, and am prepared to give any verbal explanation which may be required.

The rail I have recommended is larger and heavier than the Wilmington rail, and weighs 43 lbs. to the linear yard. This rail is I have no doubt, at least as strong as a 50 lb. rail of any other form.

I propose to lay this rail in the following manner, viz: First, white pine plank 3 by 8 inches, firmly bedded in sand or gravel; this is the *sub sill*, the uses of which have been already explained: on this will be placed, and fastened to it with a *tree nail* the cross ties of white oak or chestnut 7 1-2 feet long by 6 inches square, when dressed, placed at intervals of 2 1-2 feet apart. On the *cross ties* (dispensing with the wooden stringer,) the iron rail will be fastened into a double chair at each end, and into a single intermediate chair, as shown by the model. The double chair weighs 7 lbs. and the single 4 1-2 lbs. The rail will be still further secured in its place by wrought iron spikes (weighing 7 oz.) to each cross tie. It is proposed to prevent a longitudinal movement in the rail by a transverse ledge on the chair to fit into a hollow in the rail.

The cost of one mile of *railway*, on the above plan, is estimated as follows, viz:

| | |
|---|---|
| 25,000 feet board measure of white pine plank in lengths not less than 15 feet (including 3880 feet for extra bearing under joints of rails) delivered at Annapolis or Baltimore for $15,00 per M., | $375 00 |
| 2112 white oak or chestnut cross ties at 18 cents each, delivered on line of road at convenient points, | 380 16 |
| 704 cast iron chairs (7 lbs. each) at 3 1-2 cents per lb., | 172 00 |
| 352 intermediate chairs [4 1-2 lbs. each] at 3 1-2 cents per lb., | 55 44 |
| 8448 wrought iron spikes (7 oz. each) being 3696 lbs. at 8 cents per lb., | 295 68 |
| Workmanship,—laying track at 45 cents per linear yard, | 792 00 |
| 67 tons iron rails delivered at Annapolis or Baltimore at $66 00 per ton, (exchange 10 per cent.) | 4,422 00 |
| Hauling and distributing materials on road, | 250 00 |
| Clearing up ditches, &c., | 100 00 |
| | $6,467 28 |
| Or, in round numbers, | $6,500 00 |
| Then add for contingences of various kinds including superintendence, | 500 00 |
| Total estimate of 1 mile of superstructure, | $7,000 00 |
| Then for 20 miles of road, total cost of superstructure, | $140,000 00 |

RECAPITULATION.

| | |
|---|---|
| For superstructure as above, | $140,000 00 |
| For graduation and masonry, | $157,909 96 |
| For contingences of various kinds, such as crossings of county roads, farm bridges and roads, changes of roads, paved drains and ditches, &c., | 11,000 00 |
| Expense of Engineering, | 12,000 00 |
| " " Office, | 1,300 00 |
| Contingences of do., | 600 00 |
| Right of way, | 16,000 00 |
| For one turn-out, | 1,000 00 |
| Total amount, | $339,809 96 |

The subscriptions to the road are, I understand, in round numbers $353,000, leaving a balance after the completion of the road, to be applied to the moving power and fixtures on the road, of $13,190 04.

I believe all the estimates to be sufficiently liberal; and if so, the funds of the company will prove more than sufficient to completely finish the road in all its parts.

One great expense, and indeed the principal one, attending the repairs of railways is attributable to the perishable materials of which they are mainly composed. A process has, however, been discovered in England, by which wood is said to be rendered nearly imperishable or at least greatly retarded in its decomposition. This process is called *kyanizing*, after Mr. Kyan the discoverer; it consists simply in saturating the timber with a strong solution of *corrosive sublimate*, which it absorbs. This invention is now used by the British Admiralty in all their wooden constructions. They have experimented on it extensively, and to their entire satisfaction. It is also at this time used generally in England, and its application is not confined to the protection of wood alone but has been extended also to canvass, and is found to answer an excellent purpose for the preservation of that material from decay. The decomposing operation in timber begins in the sap wood, and the albumen must be in a fluid state, or capable of becoming so, before it can furnish food for the *fungi*, which many persons believe to be a most essential element of what is termed *dry rot*, or more properly *sap rot*. Be this as it may, and waiving all discussion of the causes which lead to the rapid decay of timber, it is sufficient to remark that Mr. Kyan's process, it is well ascertained, acts by effecting the solidification of the albumen more especially of the sap wood: thus diminishing, or entirely preventing its liability to fermentation or capability of being dissolved to furnish a pabulum for fungi.

Among other distinguished Philosophers, Prof. Faraday has carefully investigated this subject so far as chemical science can throw any light on it, and he reports most favorably of the plan; and we have the concurrent testimony of the most eminent British Engineers and Architects in favor of its utility. From all these facts, which are well understood in Great Britain, there can be no doubt of the vast importance of this discovery; and I cannot refrain from recommending a trial of it on our road, at least for the protection of the *under sills*. I have been politely furnished by the U. S. Navy Commissioners with a communication relating to experiments instituted on Kyan's process, under the directions of the Navy Board. It appears by this report, that the cost when due economy is observed in the experiment, is from 1 to 1 1-2 cents per superficial foot of 2 inches. This corresponds with one linear foot of our *sub sill*. The entire length of *sub sill* is 211,200 feet, which, at 1 1-2 cents per foot will amount to $3,168 00.

It is a matter of peculiar gratification to me to be able to state to the Board, that so far, although the most heterogenous materials have been employed on the road, consisting of whites, and blacks, North Americans, Irish, English, and German, no unpleasant occurrences, no riots nor tumults have taken place, nor have I heard of any depredations having been committed on the farms in the vicinity. Indeed, the inhabitants along the line speak in favorable terms of the conduct of the laborers. This state of things is mainly owing to the good example of the contractors, to the promptitude with which their wages have been paid, and to the prohibition of the use of spiritous liquors.

Some slight inconveniences have been experienced from the culpable negligence of the former resident of the Second Division, who has in con-

sequence been dismissed from the service of the company. The present organization is as follows:

First Division.

A. H. Mandeville, Resident.
J. J. Williams, Assistant.
W. H. Drayton, 2d Assistant.

Second Division.

Alexander Evans, Resident and Principal Assistant.
T. Donaldson, Assistant.
J. E. Addison, 2d Assistant.

To all these officers I feel greatly indebted for their industry, intelligence, devotion to the interests of the work, and correct deportment as gentlemen. To Mr. Evans, especially, the Principal Assistant, I am under many obligations for his uniformly valuable services.

Journals have been kept, by the resident engineers, of the daily transactions on the road—of the plans of the culverts, and of the various directions given to the contractors. All orders, regulations and communications from the chief engineer, in reference to the work, have been entered in a report book; and a regular record has been preserved of all the requisitions issued from the office in favor of the several contractors. These papers are, at all times, at the service of the Board.

In conclusion, I beg leave to congratulate you, gentlemen, on the successful prosecution, thus far, of your important enterprise; and to express the confident hope, strengthened by every days observation, that the citizens of Annapolis will hereafter derive from this improvement an ample reward for their liberality and public spirit.

I have the honor to be, gentlemen, Your Obedient Servant,

Geo. W. Hughes, *Chief Engineer.*

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COMMITTEE ON SCIENCE AND THE ARTS.—REPORT ON E. TILGHMAN'S RAILWAY BAR.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination an improved Railway Bar, invented by Mr. Edward Tilghman, of Philadelphia, Penn., *Report:*

That "the nature of the improvement consists in so forming the bar that there shall be a reduction of the hight usually given to the T rail between its head and the base on which it rests: thereby diminishing the leverage of the rail, while its strength and capability of being firmly secured to the cross tie, are provided for by the addition of a rib directly under the centre of the base, which rib may be made plain, trapezoidal, or with a lower web.

To fasten the rail, the lower rib is inserted in the cross ties, and wedged securely to its place, where it is supported conjointly upon the ordinary base, and the under part of the lower web. A chair, or flat plate of iron, is inserted immediately under the upper base, or support, to receive which, notches are made in the ends of the bars, so that when two of them are put together, these notches form a mortice through which the chair is to be inserted. The chair is affixed to the cross ties" by spikes or screws.

The Committee having tested the strength of the improved *trapezoidal* rail, weight 48 lbs. per yard, by the rules laid down by Professor Barlow in his account of "Experiments on the transverse strength and other properties of malleable iron, with reference to its uses for railway bars," feel

satisfied it will sustain a weight of from six to seven tons without injury, [the supports being 33 inches apart] or about 75 per cent. more than the most approved rail of similar weight now in use.

With reference to *leverage*, the improved rail is decidedly preferable to the T rail, the distance between the upper surface and support being considerably less, and as its entire depth is greater than that of any other rail known to the Committee, [and may be increased at a slight expense without changing the position of the main support, or increasing the leverage,] it consequently follows, as the depth governs the deflexion, that the improved rail is much the most stiff and rigid.

In point of economy, the Committee are of opinion that the improved *trapezoidal* rail will be found less expensive than the T rail. The plan suggested for connecting the bars, and attaching them to the sills, they conceive permanent and simple.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

*March* 14, 1839.

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REPORT ON EASTWICK AND HARRISON'S EIGHT WHEEL LOCOMOTIVES.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for examination Messrs. Eastwick & Harrison's Eight Wheel Locomotives, *Report:*

That these engines possess two peculiarities of an important character; one in the arrangement of the driving wheels, and the other in the mode of maintaining the fire draft.

It is well known to engineers, that the efficiency of the locomotive engine depends, first upon the quantity of steam which the boiler may be capable of generating in a given time, and secondly on the amount of friction, or, as it is technically termed, adhesion, between the driving wheels and the road. As the adhesion increases with the weight, it is evident that the engine becomes more effective by increasing its weight, and by throwing a greater proportion of this weight on the drivers.

But a limit to this increase of weight arises from the incapacity of the road to sustain the great pressure thus thrown on a small bearing surface.

To obviate this difficulty, engines have been made with all the wheels coupled so as to constitute them all drivers, and thus distribute the *adhesive* pressure over a greater extent of the road.

Engines of this description are used for heavy and slow draught, but are considered unsafe, from their liability to be thrown off the track at curves.

Another plan, patented a few years back by an engineer of this city, was to use four drivers, and at the same time to carry the front end of the engine on a guide truck, as in the six wheeled engine. But here a new difficulty arose in consequence of the engine having three points of bearing in the line of the rails, on which its weight could not be properly distributed, unless the road was entirely free from irregularities of surface: a condition not to be found on any of the roads which have come under the notice of the Committee.

The improvement invented by Messrs. Eastwick and Harrison is designed to obviate this difficulty, by giving to the eight wheel engine only two bearing points, one on the guide truck, and the other on a frame supported by the driving wheels. The axles of the drivers are placed one in front, and the other behind, the fire box, and are confined between pedestals of the

usual form fixed to the main frame of the engine, which allow vertical play, but prevent any horizontal motion.

The bearing pins, instead of abutting against springs fixed to the frame in the ordinary manner, are jointed to the extremities of horizontal beams of cast iron, one of which is placed on each side of the engine.

To the centre of these beams, or levers, are jointed wrought iron rods, which pass down through the engine frame, and carry the springs which support the weight of the engine. The connecting rod of the piston is attached to the hinder wheel, and this communicates motion to the front driver by a coupling rod attached by a ball and socket joint.

It is evident that this arrangement will allow to each driving wheel, an independent vertical motion, with the advantage that the engine will partake of only one half the vertical motion of either wheel, in consequence of being suspended at the centre of the horizontal sustaining beam.

The front drivers are without flanches, in order to avoid any difficulty in turning curves.

The peculiarity in the means of maintaining the fire draft, is an apparatus for equalizing the effect of the exhaust steam in the smoke stack, somewhat similar to Gurney's contrivance.

Instead of exhausting directly into the stack, the exhausted steam enters two copper chests, one connected with each cylinder, and escapes from these into the chimney through a number of small tubes.

With the aid of this contrivance the anthracite fire is kept in a state of intense activity, and generates an abundance of steam without the annoyance and danger arising from the smoke and sparks of a wood fire.

The heat of the anthracite fire has been found so great as to melt down the grate bars of cast iron which were used in the first experiments with this fuel.

Messrs. E. & H. have since substituted grooved wrought iron bars, which are protected from the action of the fire by a coating of clay placed within the grooves.

A trial of one of these engines on the road between Broad street and Peter's Island, was witnessed by several members of the Committee, on the 25th of April last.

It happened unfortunately, on that occasion, that the business of the road did not furnish so many cars as were desirable for a fair experiment.

The particulars so far as made known to the Committee, were as follows:

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|---|---|
| Weight of engine, 28,350 lbs., | Weight on drivers, 18,059 lbs. |
| Cylinders, 12 inches diameter, | Steam, 90 lbs. to square inch. |
| Length of stroke, 18 inches, | Driving wheels, 44 inches diameter. |

The train consisted of 32 loaded cars, estimated at 5 tons each, 2 empty cars weighing 9800 lbs., and tender, 5 tons making a total of 169 tons. This train was started with great ease on a rising grade of 27 feet to the mile, and drawn to the foot of the inclined plane, the distance being about 3 miles, partly on a rising grade of 35 feet to the mile, with several short curves, and the road in such bad condition as to keep the sustaining beam in continual vibration.

A few days after this experiment, one member of the Committee had an opportunity of witnessing a more decisive trial of the power of the engine.

On the latter occasion, the train consisted of 34 single cars, estimated at 5 tons each, 4 double cars, 10 tons each; one of Mr. Dougherty's iron boats 50 tons, and the tender 5 tons; total, 265 tons.

This train was started without difficulty, on the same rising grade of 27 feet to the mile, and drawn over the 35 foot ascending grade and short curves with apparent ease, and with steam blowing off during the whole trip.

This highly interesting experiment was brought to a close somewhat abruptly after proceeding about 2 miles, by the breaking down of one of the cars near the middle of the train.

Although this accident abridged the trial of the power of the engine for draught, it afforded an apportunity of displaying another excellent trait in its performance, this was the facility of reversing* while under way.

As soon as the accident happened, a person stationed on the after part of the train passed a signal to the engineer, the latter immediately reversed the engine and brought the enormous moving mass to a stand before it had run half its own length. The satisfactory character of the experiments detailed above is sufficient to enable any one who is conversant with transportation on railroads, to form a correct opinion of the merits of this engine. The impression of those members of the Committee who witnessed the trials, is, that it is well adapted for the use of anthracite as fuel, and for very heavy draught; with less tendency to injure the road or to receive injury on a bad road than engines of the usual construction.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

May 9, 1839.

At the request of Messrs. Eastwick and Harrison, the Committee insert the following letter from A. Pardee, Jr. Esq., Engineer of the Beaver Meadow Railroad, in reply to their letter requesting information relative to the construction of the road and the performance of their engine upon it.

COM. PUB.

*Hazleton, Pa., June 8th,* 1839.

MESSRS. EASTWICK & HARRISON,

Gentlemen--I have received your's requesting information as to the construction, &c. of the roads in this region, on which your eight wheeled Locomotives are employed.

The Beaver Meadow railroad, where one of those engines has been in use two years, has an iron plate rail of 2 1-4 by 5-8 inches; the wooden rails or string pieces, are oak, a portion 5×7, the remainder 5×8 inches; where the 5×7 rails are used, the cross ties are placed three feet from centre to centre, where the 5×8 they are four feet. The cross ties are laid on plank mud-sills 2 1-2 inches thick by 10 to 12 inches wide. The shortest curve has a radius of 300 feet; length about 200; but at the foot of the inclined planes, there is a curve, around which the engines now daily pass, the radius of which is 250 feet, the length about 300. The heaviest grade is 96 feet per mile, at two points, about 3-4 mile each, there is an average grade of 80 feet per mile for 5 miles—on the heaviest grade the shortest curve is 550 feet radius, the length about 400 feet. The Hazleton railroad on which two of your eight wheel engines are now in use, has a plate rail 2 1-4 by 5-8 inches, the string pieces are yellow pine 5×9 inches, the cross ties 4 feet apart, from centre to centre, the mud-sills 2 1-2 by 10 to 12 inches. The heaviest grade is 140 feet per mile for 1 1-2 miles; this part of the road was not intended, when made, for the use of locomotive power, but it was found in practice that by doubling our trips we could use the engines with more economy than horse power. In regard to the effect on the road, so far as my experience goes, and I have seen the two classes of engines in daily use for more than two years, I would say that the eight wheel engine was easier on the road than a six wheel engine of the ordinary construction,

* For a report on this mode of reversing, see Journal of Franklin Institute, vol. xviii., p. 179.

with the same weight on the two driving wheels as on each pair of the driving wheels of the eight wheeled.

There are now in use on the Beaver Meadow and Hazleton railroads, seven locomotive engines with horizontal tubular boilers, in which anthracite coal is exclusively used as a fuel after the first fire in the morning, and that we continue to use it when we can have wood for the cost of cutting, is sufficient evidence that we find it to our advantage. We have the Hercules at work, and so far, she performs well, running around the curves with great ease. Respectfully yours,

A. PARDEE, JR.

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## THE READING RAILROAD: ITS ADVANTAGES FOR THE CHEAP TRANSPORTATION OF COAL, AS COMPARED WITH THE SCHUYLKILL NAVIGATION AND LEHIGH CANAL. NOS. I. TO VIII. BY W. EDWARD.

*To Elihu Chauncey, Esq., as a tribute of admiration for the eminent services he has rendered to the Reading Railroad Company, by his able, firm, and enlightened advocacy of its true interests.*

### READING RAILROAD.—NO. I.

The great importance to Pennsylvania of a cheap means of transporting her Anthracite Coal from the mines to the sea-board, has engaged much of the time and attention of her scientific men, and large sums of money have been expended in various undertakings with a view to this object.

Among the most successful of these are the Schuylkill navigation company's canal, and that of the Lehigh coal and navigation company, in connection with the State canal on the Delaware.

The project of a continuous railroad from the mines at Pottsville to the river Delaware first received the legislative sanction in 1833, the work was commenced in 1835, and has since that period been steadily and rapidly advancing towards completion.

So far as it has progressed, the Reading railroad, will, it is believed, bear comparison with any similar work, and is generally conceded to be one of the best constructed railways in the United States.

The object of these papers will be to show, according to the experience of railway companies in England engaged in the transportation of coal, and from other known data, the advantages of this road when compared with the other avenues by which our anthracite is at present brought to market, particularly with the Schuylkill navigation and Lehigh canal—these being acknowledged the most successful works *yet* in operation.

In the commencement, as I purpose to enter fully into detail, it may not be amiss to notice an erroneous impression entertained by many, who say, generally, that "canals are cheaper than railroads as a means of transporting heavy freight."

I am well aware that many canals are a much cheaper means of transportation than railroads, but in inquiring into this subject fully, it is necessary that all attendant circumstances be taken into account.

Thus it may be said, that the cost of transporting heavy goods is less per ton by the Duke of Bridgewater's canal than by the Liverpool and Manchester railway; but it must be borne in mind, that this canal is a level of 27 miles with only one set of locks, four in number, at its entrance into the river Mersey, with sixteen miles of tide-way by that river to Liverpool, and that the Liverpool and Manchester railway has ascents and descents varying from 6 feet to 55 feet per mile.

When, however, we compare a canal, such as the Schuylkill navigation

company's 108 miles long, having 117 lift locks, overcoming in all a fall of 610 feet, and changing from one side of the river schuylkill to the other—with the Reading railroad, 94 miles in length, having in its course from the mines no ascent whatever to overcome (with the exception of about a mile between the Delaware and Schuylkill, where the assistance of an additional locomotive will enable the trains to pass without delay,) the line generally varying from a level to descents of 19 feet per mile—it will be perceived that the result of the comparison may be widely different.

### READNIG RAILROAD.—NO. II.

This railway commences at Pottsville, and there connects with the Mount Carbon railroad, and by means of it with the Danville and Pottsville railroad. It will also, at the same place or at Mount Carbon, half a mile below Pottsville, be connected with the Mill Creek and Schuylkill Valley railroads, either by the extension of one or other of these last named railroads, or by a branch of the Reading railroad of less than two miles to Port Carbon. At Schuylkill Haven, four and a half miles below Pottsville, it connects with the Mine Hill and Schuylkill Haven railroads; and at Port Clinton, 15 miles below Pottsville, it connects with the Little Schuylkill railroad, by which latter railway the Lehigh coal and navigation company can transport their coal to the Reading railroad.

It will thus be perceived that the Reading railway connects with all the railroads in the coal region, by which the coal is at present brought in *cars* to the Schuylkill canal; and that by means of the Little Schuylkill railroad, which reaches the valuable coal lands of the Lehigh company on the west, *they, also, will be enabled* to reach the Reading railroad at Port Clinton.

From Port Clinton the Reading railroad continues down to Philadelphia, passing through Reading and Pottsgrove, and terminating on the river Delaware.

Within five and a half miles of its termination, a branch road on the west side of the Schuylkill, two miles in length, connects with the Columbia railroad, at the west end of the Columbia railroad bridge.

There are no ascents whatever on this road in its whole course from the mines, [with the exception of about a mile between the Schuylkill and Delaware, where the assistance of an additional locomotive will enable the full trains to pass without delay;] the line generally varies from a level to descents of 19 feet per mile, and is without precedent as regards its peculiar aptitude to the trade it is intended to accommodate.

As the capability of this railway, with all its advantages, entirely to supersede the Schuylkill navigation and Lehigh canal is frequently denied by persons interested in these companies, it will be necessary to ascertain their present means of transportation, and *hereafter* to examine the cost of freighting, labor, wastage of coal, &c. by these channels, and see what reductions can be made by them when *forced* thereto by the operation of the Reading railroad.

And first, we will inquire what constitutes the Schuylkill navigation? The works extend from the dam at Fairmount, near Philadelphia, to Port Carbon, and consist of a succession of canals and pools. The pool above Fairmount dam is entered by a short canal on the west side of the Schuylkill—this pool extends about six miles to Flat Rock. About one and a half miles from Flat Rock Dam, the Manayunk Canal leaves the last mentioned pool and rejoins the stream a short distance above the dam, and thus enters the second pool. This extends four miles to an inconsiderable canal, which connects it with the pool above; three miles further, another

small canal conducts into the pool above Norristown; thence the stream is ascended by several short canals and pools to the commencement of the Oak's canal, three and a half miles in length. The Oak's canal commences half a mile above the outlet of Perkiomen Creek, and extends along the north or left bank of the Schuylkill, to a dam, about one mile above Phœnixville, where it enters the river. The pool, formed by the dam just mentioned, extends to the outlet of the Vincent canal, nearly five miles in length. About one mile above the termination of the Vincent canal, commences the Girard canal, one of the most extensive in the series. It is twenty-two miles in length, and extends along the right bank of the Schuylkill to Pigeon Creek, five miles below Reading. Between that point and Reading there are two dams and a small canal. With the exception of the Hamburg canal, ten miles in length, and another of three miles, the distance from Reading to Hamburg is traversed by a succession of short canals, mostly on the left bank of the Schuylkill. This is also the case from Hamburg to Port Carbon, where the navigation terminates. The canals are twenty-seven in number, and in length 58 miles—there are thirty-four dams and pools—length of pools 50 miles—entire length, 108 miles. The canals are thirty-six feet wide at top, twenty-two at bottom, and three feet six inches deep. There are one hundred and seventeen lift locks, each eighty by seventeen feet—one tunnel 385 feet long—total rise 610 feet. With a few exceptions the locks are double on the whole line.*

On the first day of January, 1839, the affairs of the Schuylkill navigation company stood thus:

| | | |
|---|---|---|
| Capital stock 33,312, shares at $50, | | $1,665,600 00 |
| Permanent loans, | 1,914,166 93 | |
| Amount paid, | 75,743 97 | |
| | | 1,838,422 96 |
| Bond payable given for damages, | | 8,000 00 |
| Temporary loan from toll fund, | | 52,205 12 |
| | | 3,564,228 08 |
| Deduct—Bonds receivable for lands sold, | 13,958 18 | |
| Contingent funds, | 18,625 81 | |
| | | 32,583 99 |
| | | $3,531,644 09 |

Assuming the market price of the stock at $150 per share, it would add to the above $3,331,200—making in all six millions, eight hundred and sixty-two thousand, eight hundred and forty-four dollars and nine cents [$6,862,844 09]. But as the purpose of these papers is to show the advantage of the Reading railroad over the Schuylkill navigation and Lehigh canal, it would not be correct to look to the market price of their shares, but base our estimates on their par value.

The annual cost of the Schuylkill navigation is :—

| | |
|---|---|
| Six per cent. on capital stock, $1,665,600, | $99,936 00 |
| Five and a half per cent. on loans $1,838,422, | 101,113 21 |
| † Current expenses, being cost of repairs, salary of officers, lock tenders, wages, &c., average of 1837 and 1838, | 121,246 82 |
| | $322,296 03 |

Requiring 732,400 tons, at 50 cents per ton, to pay the same.

* See Schuylkill navigation company's reports, and Tanner's description of the canals and railroads of the United States, Philadelphia, Nov. 1834.

† There was also expended and charged to permanent improvements, during 1837 and 1838, the sum of $290,444 94, or $145,222 47 annually.

The maximum cost of the Reading railroad when finished, including land damages and purchases of property for wharves, depots, &c. will be four million dollars.

| | |
|---|---|
| Capital stock, | $2,000,000 00 |
| Loans in England at 5 per cent., | 2,000,000 00 |
| | $4,000,000 00 |
| And the annual cost will be 6 per cent. on capital stock, $2,000,000, | 120,000 00 |
| Five per cent. on loans, 2,000,000, | 100,000 00 |
| Current expenses, being for wear and tear of roads, repairs, salaries of officers, agents and hands engaged at depots and landings, | 145,200 00 |
| Annual expenses of an additional locomotive between Delaware and Schuylkill, | 6,000 00 |
| | $371,200 00 |

Requiring 732,400 tons at 50 cents per ton to pay the same.

In connection with this view of the subject it may be remarked, that the capacity of the canal is limited, while over the railway two millions of tons may be transported annually if required.

Annexed is a table, showing the diminished cost per ton for use of road, as the trade may increase, which will likewise apply to the Schuylkill navigation, to the extent of its ability, and the annual cost of either would not be further increased beyond a moderate per centage on the amount of increased tonnage.

TABLE.

| | *Dolls.* | | *Tons.* | *Per Ton.* |
|---|---|---|---|---|
| Annual road cost, | 371,201 | requiring | 742,400 | at 50 cents. |
| " | 371,200 | " | 822,667 | at 45 " |
| " | 371,200 | " | 928,000 | at 40 " |
| " | 371,200 | " | 1060,555 | at 35 " |
| " | 371,200 | " | 1237,333 | at 30 " |
| " | 371,200 | " | 1484,800 | at 25 " |

READING RAILROAD.—NO. III.

In this number we will examine the cost, per ton, of freighting coal by the Schuylkill navigation, including cost of labor and wastage of coal in screening and shipping, &c., and also the cost per ton for motive power, use of cars, expense of shipping, &c., by the Reading railway.

A boat costing $550, is capable of carrying from 55 to 57 tons each trip, and would, were there no detentions other than the passing of the locks, be able to make twenty trips in the season of eight months, the time the canals are usually open—but owing to the occasional overflowings of the tow paths, by spring and fall freshets, and to the droughts of summer, the full average number of trips is 17, and the average load 54 14-20 tons, making in all an annual tonnage for each boat of 930 tons—average time of each trip up and down, two weeks. The annual expense of a boat will be as follows:

| | |
|---|---|
| First cost of boat, | $550 00 |
| Interest for first year, $550, at 6 per cent., | 33 00 |
| Repairs, | 00 |
| | 583 00 |

| | |
|---|---|
| Deduct for 17 trips at $10 58 each trip, | 179 86 |
| | $403 14 |
| Prior to commencing the second year's operations the boat will require caulking, &c., costing | $25 00 |
| Interest for second year on $428 14, | 25 69 |
| | 453 83 |
| Deduct for 17 trips, at $10 58 each trip, | 179 86 |
| | 273 97 |
| Prior to the third year's operations, the boat will require repairs to the extent of | 50 00 |
| Interest for third year on $323 97, | 19 44 |
| | 343 41 |
| Deduct for 17 trips, at $10 58 each trip, | 179 86 |
| | 163 55 |
| Prior to the fourth year's operations, the boat will require repairs to the extent of | 80 00 |
| Interest for fourth year on $243 55, | 14 61 |
| | 258 16 |
| Deduct for 17 trips at $10 58 each trip, | 179 86 |
| | 78 30 |
| Prior to the fifth year's operations the boat will require repairs to the extent of | 100 00 |
| Interest for fifth year on $178 30, | 10 70 |
| | 189 00 |
| Deduct for 17 trips, at $10 58 each trip, | 179 86 |
| | $9 14 |

After the fifth year, the boat would cost as much to repair as it would earn; it may be said to be worn out, and is usually sold at from 10 to 25 dollars.

| | |
|---|---|
| Annual cost of a boat $179 86, or for each trip, | $10 58 |
| Captain's wages per trip, | 10 00 |
| Man's do. do., | 7 00 |
| Boy's do. do., | 4 00 |
| Food for captain, man and boy, per trip, | 15 00 |
| Food for horse, | 4 80 |
| Use of horse, and cost of towing lines, | 3 50 |
| 24 ferriages (12 each way,) | 1 38 |
| Unloading of boat at wharves on Schuylkill, | 5 00 |
| Back toll on empty boat, | 2 40 |
| Total cost of freighting 54 14-20 tons, | $63 66 |

or one dollar sixteen and a half cents per ton.

The freights *actually paid* on the Schuylkill navigation averaged, in 1835, $1 19—in 1836, $1 50 1-2—in 1837, $1 27 1-4—and in 1838, $1 16—being an average for the last four years of $1 28 per ton.

The cost of transporting one ton of coal from the landings at Pottsville, and delivering it on board a vessel in the Schuylkill, per Schuylkill navigation, during the years 1835, 1836, 1837 and 1838, averaged $3 23 1-2, and was as follows:

| | |
|---|---|
| Cost of labor at landings in Pottsville, including 5 cents per ton wastage, caused by passing the coal over screens into canal boats, | $0 12 |

Cost of labor at the wharves in Philadelphia, in-

| | |
|---|---|
| screening, wheeling and shipping, (including piling of one fourth of all the coal brought down,) | 0 20 |
| Loss of coal in handling as above, | 0 17 1-2 |
| Wharf rents, clerk hire, use of screens, &c., | 0 18 |
| Toll, | 0 92 |
| Freight, average of 1835, 1836, 1837 and 1838, | 1 28 |
| Loss of coal, being difference between the Schuylkill navigation company's weight (by which the coal dealers pay for the coal, freight and toll) and the quantity actually delivered from the boats, estimated at | 0 36 |
| | $3 23 1-2 |

We now examine the cost, per ton, by the Reading railway from the same points at Pottsville, *where the coal, instead of being emptied from the cars into the canal boats, is carried in the same cars to the wharves on the river Delaware, and there discharged into the hold of the vessel.*

The power of a locomotive engine of 12 inch cylinder and 18 inch stroke, working under a pressure of from 70 to 80 pounds, and constructed with a view to *heavy transportation*, would be equal to the traction *on this road* of 200 tons nett at ten miles per hour.

An engine with her load will perform the trip from the coal region to Philadelphia [94 miles] *in one night*, and return in the next, making the performance of each engine one hundred and fifty trips *per annum.*

The annual cost of a locomotive and tender on this road will be as follows:

| | |
|---|---|
| Engineer's salary, $60 per month, | $720 00 |
| Fireman's pay, $36 per month, | 432 00 |
| Fuel, 4 tons of coal per trip, [up and down] or 600 tons *per annum*, at an average cost of $2 50 per ton, | 1500 00 |
| Oil, 2 gallons per trip, or 300 gallons *per annum*, at 90 cents per gallon, | 270 00 |
| Repairs and depreciation of engine and tender estimated at 25 per cent. on cost, $8000, | 2000 00 |
| | $4922 00 |

This amount divided by 30,000, the number of tons annually drawn by each engine, gives 16 2-5 cents per ton, as the cost of motive power.

But, as this may be considered the maximum power of a locomotive on this road, we also give a calculation based upon the minimum power of the engine, and adopt the latter in our estimates.

The annual cost of a locomotive engine, performing on this road one hundred trips annually [up and down], and drawing 150 tons nett at each trip, will be as follows:

| | |
|---|---|
| Engineer's pay at $4 80 per trip, | 480 00 |
| Fireman's pay at $2 80 per trip, | 280 00 |
| Fuel, 4 tons of coal per trip [up and down], or 400 tons per annum, at an average of $2 50 per ton, | 1000 00 |
| Oil, 2 gallons per trip, or 200 gallons *per annum*, at 90 cents per gallon, | 180 00 |
| Repairs and depreciation of engine and tender, estimated for 100 trips, at 20 per cent. on cost, $8000, | 1600 00 |
| | $3540 00 |

This amount divided by 15,000, the number of tons annually drawn by each engine, gives 23 6-10 cents per ton as the cost of motive power.

A car with springs, costing $250, will be able to perform 125 trips up and down annually, with three tons each time, in all 375 tons, and the annual wear and tear, attendance and oil, will be as follows:

| | |
|---|---|
| Proportion of wages for men attending the trains, five men being required to attend a train of fifty cars, | $25 00 |
| Oil, 20 gallons *per annum* for each car, at 90 cents per gallon, | 18 00 |
| Repairs and depreciations, 25 per cent. on first cost, $250, | 62 50 |
| | $105 50 |

This amount divided by 375, the number of tons annually carried in each car, gives 28 1-4 cents per ton for use of cars.

| | |
|---|---|
| Thus we have for cost of motive power per ton, | 23 1-2 |
| For use of cars, | 28 1-4 |
| To which is to be added for increased care in screening coal at mines, per ton, | 12 |
| Expense of discharging coal from cars into the vessels in the Delaware, including cost for detention of cars containing 1-10th of all coal brought down, clerk hire, wharf rent, &c., | 15 |
| Total cost per ton of freighting and shipping by the Reading Railway, | $0 78 3-4 |
| Total cost per ton of freighting and shipping [exclusive of toll] per Schuylkill Navigation, | 2 31 1-2 |
| Total cost per ton of freighting and shipping [exclusive of toll] per Reading railroad, | 78 3-4 |
| Difference per ton in favour of railway, | $1 52 3-4 |
| To this must be added 10 cents per ton, being difference in freights coastwise in favor of receiving cargo on the delaware, | 10 |
| Total difference per ton in favor of the railway, | $1 62 3-4 |

### READING RAILROAD.—NO. IV.

As regards the question, will the coal sustain injury while in the cars in passing on the railroad from Pottsville to this city? the experience of all the coal dealers so far as relates to railroad transportation, has been the same, whether the coal has passed while in the cars, over the railroads 1 mile, 3 miles, 5 miles, 10 miles, or 20 miles, to reach the Schuylkill navigation---that there is no sensible increase of dust or waste coal; and the conclusion of all with whom the writer has consulted (and they are many of the largest operators on the Schuylkill) is, that the injury to the coal arises chiefly from the loading and unloading, and not from the passage over the road in the cars.

Thus, it is evident, that if the same cars into which the coal is loaded at the mouth of the mines can be brougbt down to Philadelphia without any further loading or unloading, (the coal being carefully screened when put

NOTE—In the last annual report of the Schuylkill navigation company, there is an estimate of the loss of coal by waste, during the year 1838. It amounts to forty-one thousand five hundred and ten tons.

into the cars,) that all the loss arising from the present mixed means of transportation will be avoided---and this has been considered so great a desideratum, that in Scotland the following plan has been adopted:

It will be found in a work written by Thomas Graham (a friend to canals), and published in Glasgow, in 1836, he says:---

"I last Autumn suggested the plan and construction of a boat for carrying loaded railway wagons, and a boat of this description has now been completed. The Forth and Clyde canal connects the east and west of Scotland; about the middle of its course it is joined by the Monkland and Kirkintilloch railway, and receives from it large supplies of coal; which are unloaded from the railway wagons into the vessels navigating the canals, and conveyed by them coastwise to the various seaports of Britain and Ireland. Nothing is cheaper or more advantageous than this mode of transport, *so far as respects coasting vessels capable of entering the canal;* but there is a considerable disadvantage respecting the supply of coals to manufactories situated on or near to the banks of the canal; and also respecting the supply of coal to large sea vessels of many hundred tons burthen, which cannot enter the canal, but discharge their cargoes at the entrance of the canal into canal lighters, to be carried in these vessels through the canal. The coal brought along the railway, has in each of these cases, after being put on board a canal lighter and conveyed along the canal, the following disadvantage, viz: when brought to the point nearest to the manufactory where it is to be consumed, it must be unloaded from the lighter and laid on the canal banks--then loaded into a cart and carted to the manufactory. If the coals, on the other hand, is wanted for loading a sea vessel, which cannot enter the canal, then the lighter which has brought it from the railway goes out of the canal, and being laid along the high side of the sea vessel, the coal is lifted from the lighter and laid on the deck of the sea vessel, and thrown into the hold. The price of coal at Kirkintilloch, where the railway joins the canal, does not average four shillings per ton—the addition to this price, consequent on these *repeated loadings and unloadings,* is, therefore, considerable; and by the same operations *the coal is much broken and injured, and a considerable loss of value is incurred.*

"The wagon-boat completely obviates these disadvantages. The loaded railway wagons are run from the end of the railway directly upon the deck of the canal wagon boat, which is traversed by lines of rails for this purpose with the requisite turning plates. When the boat has got its full compliment of wagons on board, it is drawn to the point where the coal is to be delivered. In the case of a manufactory, by laying a few rails from the canal bank, the wagons are run from the deck of the boat to the manufactory where the coal is to be consumed, and the consumer thus receives the coal *in the same state that it came out of the mouth or opening of the coal mine.* When, on the other hand, the coal is to be loaded on board of a sea vessel, the canal wagon boat does not descend the lock which joins the canal to the sea, but remains on the level above the sea vessel; the wagons are then run from the deck of the wagon boat, and by means of a short railway are conveyed along the canal bank and wharves to the sea quay, where the large sea vessels are moored, *and the coals are at once discharged from the wagons into these sea vessels.* In this way the largest vessel has the same advantage and accommodation in receiving a loading of coal as the smallest lighter, and the *railway is thus in fact carried to every point of the canal.* The wagon boat now in use on the Forth and Clyde Canal, carries wagons with a load of nearly forty tons of coal."

How far the introduction of similar boats would answer upon a line of improvements such as the Schuylkill navigation, we may hereafter inquire

Having in the former numbers examined the grades and length of this railway, and the lockage and length of the Schuylkill navigation; having also examined the annual cost of both these works, and shown the number of tons required by each, at a given rate of toll, to pay the same; having shown the total cost per ton for freighting and shipping by the Schuylkill navigation, and the same by railroad, upon the single article of coal, *which it may be said will be the* NIGHT *or* EXTRA *business of the road*, leaving it the full day to perform its transport of passengers and goods---before showing the large revenue to be derived from these last named sources [which we postpone to another number,] we will show the exact correspondence of the charges for motive power, as stated by us, when compared with the Stockton and Darlington railroad, *used almost exclusively for the transportation of coal.*

The length of the Stockton and Darlington railway, or rather of that part of it on which locomotives are used, is twenty miles, and the grade of the same is descending from the mines, varying from about 3 feet to 50 feet per mile.

The load of the locomotive is limited to its power to bring back the empty cars up the grades. The descending load is composed of 63 1-2 tons of coal in 24 cars weighing 31 tons, in all 94 1-2 tons; the ascending load is the 24 empty cars weighing 31 tons. The engines perform two trips up and down daily, or 80 miles. The Directors of the Stockton and Darlington railroad have entered into a contract with three responsible persons to supply the motive power. The company pay them 4-10 of a penny, or 7 1-2 mills, per ton per mile for coal carried down, and there is no charge for bringing back the empty cars. For this price the contractors keep the engines in complete repair, furnish workmen and materials, and pay all the current expenses of haulage; such as engineer's and fireman's salaries, fuel, oil, &c., besides an interest of 5 per cent. to the company on the value of the engines and workshops used by them.

On the Stockton and Darlington railway the engines never go off but with full loads; and were the grades of that road similar to those of the Reading railroad, the power of the same engines would be equal to bringing back 72 empty cars, weighing 93 tons, and the descending load would comprise 190 1-2 tons of coal and 72 cars, weighing 93 tons; in all 283 1-2 tons---and the charge per ton per mile would be 2 1-2 mills instead of 7 1-2 mills as above; or for 94 miles, the length of the Reading railroad 23 1-2 cents per ton, being exactly the same cost as estimated in No. III. The price of labor, iron, &c., for the engines used on the Stockton and Darlington railway may be estimated at 20 per cent. less on the Reading railway; but this is counterbalanced by the engines on the Reading railroad performing a trip of 94 miles nightly, while on the other the engines are obliged to be attached to, and detached from, the trains four times daily, and perform only eighty miles per day.

On the Liverpool and Manchester railway, during the year ending June 30, 1834, the quantity of passengers carried over the road was, in tons, 39,420, and the gross receipts therefor, 105,456*l.* 3*s.* 10*d.*, or 2*l.* 12*s.* 6*d.* per ton of passengers. The quantity of merchandize carried during the same period, was 202,603 tons, and the gross receipts [less amounts paid for cartage in Manchester and Liverpool] were 74,883*l.* 11*s.* 11*d.*, or 7 shillings and 4 3-4 pence per ton, and the quantity of coals carried an average distance of 15 miles was 86,173 tons, and the gross receipts therefor 5,517*l.* 2*s.* 5*d.* or 15 1-4 pence per ton for 15 miles,* *being 1 cent and 9 mills per ton per mile for motive power, use of cars, and tolls.*

***In the Report of the Liverpool and Manchester railway Company, for the six months**

Annexed, is the opinion and guarantee of Mr. William Norris, of our city, most favorably known in Europe as well as in this country as a builder of locomotives, showing the power of his engines on the Reading railway.

PHILADELPHIA, February 26, 1839.

DEAR SIR:---In reply to your request for information, as to the capability of my locomotives in their performances on the Reading railroad, I have the pleasure of stating, that my class B [the same size as those in daily use on the Philadelphia and Baltimore, and the Baltimore and Washington, and various other roads] can, with *every facility*, do the following duty *per annum:*

One hundred and fifty trips from the coal region to Philadelphia, each trip with a load of 200 tons of coal in 67 cars, making a gross load, with weight of cars, of about 290 tons, to be performed in all cases within *ten* hours. The engine returning in the same time, from Philadelphia to the coal region with the 67 cars in one train.

The annual cost for maintaining one locomotive and tender, will not exceed the following, viz:

| | |
|---|---|
| Salary of engine man and fireman. | 1,200 |
| 600 tons of coal at $2 50, | 1,500 |
| Oil, | 300 |
| Repairs and depreciation of engine and tender, | 2,000 |
| | $5,000 |

Thus showing, that one of my locomotives of class B can, at a cost of $5,000 *per annum* [all charges included] transport from Pottsville to Philadelphia, 30,000 tons of coal *per annum*, which will give but 16 2-3 cents, as cost of motive power, per ton, for the whole line of 94 miles, including the taking back of the empty cars.

I am so well assured of the above facts, from the performances of my machines, during the last three years, that I will guarantee all I have said above, provided I have the selection and charge of the engine men.

Yours, very respectfully,

WILLIAM NORRIS.

(To be continued.)

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HARLEM RAILROAD RECEIPTS.

| | | | | |
|---|---|---|---|---|
| In May, | 1838, | $7,937 62 | In 1839, | $9,663 96 |
| June, | " | 8,897 59 | " | 11,911 99 |
| July, | " | 11,240 76 | " | 12,001 22 |
| Aug., | " | 9,969 23 | " | 12,626 74 |
| To 23d Sept., | " | 6,739 90 | " | 9,867 66 |
| | | $44,785 10 | | $56,071 57 |

Showing an increase over the same period of last year of $11,286 47, in only 4 months and 22 days, and these receipts are at the rate of $141,164 00 per annum.

The total expenses of every sort and kind are $75,000 per annum, and the interest on their debt $21,000--together, $96,000 per annum; leaving the balance of its receipts, whatever they may be, for a dividend.—*Gaz.*

ending June 30, 1832, which is more in detail than the subsequent ones, it will be found that there was carried on this road (from the mines chiefly to Liverpool, thereby avoiding the heavy grades) 22,045 tons of coal in 234 trips, being about 94 tons each trip. Of merchandize there was carried 72,601 tons in 2,248 trips, or about 32 tons each trip; and there was carried 174,122 passengers, equal to 17,212 tons, in 2,636 trips, or 6 1-2 tons each trip. The total number of trips was 5,118, and the total tonnage 111,858 tons, being an average of 22 tons nett each trip, or, including cars and carriages, about 32 tons gross load.

Table of the mean temperature of each of the months for the years of 1833, 1834, 1835, 1836, 1837, and 1838. Also the day the thermometer was at the *extreme* lowest and highest; and the number of days that was clear, cloudy, rainy, white frost, foggy morning, snow, hail, or sleet, in each month. From the meteorological record kept at Avoylle Ferry, on Red river, Louisiana. Lat. 31° 10″ north, lon. 91° 59″ west, nearly. By P. G. Voorhies.

| Date. | | Mean temp. of months. | | | | Thermometer, the extreme in each month. | | | | | | Number of days in each month that was either | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Morn | Noon | Night | of the m'nth | Day. | | low'st | Date. | | high't | Clear | Cl'dy | Rainy | white frost. | foggy morn. | Snow | hail or sleet |
| JANUARY | 1833 | 51 | 62 | 60 | 57 | JANUARY | 18th | 30 | JANUARY | 30th | 72 | 19 | 12 | 4 | 1 | 2 | | |
| | 1834 | 44 | 51 | 49 | 48 | " | 5 | 16 | " | 11 | 76 | 4 | 27 | 19 | 1 | 1 | 3 | |
| | 1835 | 45 | 60 | 56 | 54 | " | 6 | 29 | " | 26 | 86 | 19 | 12 | 10 | 4 | | | |
| | 1836 | 46 | 59 | 58 | 54 | " | 28 | 26 | " | 16 | 74 | 19 | 12 | 9 | 6 | | | |
| | 1837 | 39 | 53 | 46 | 46 | " | 15 | 24 | " | 18 | 70 | 20 | 11 | 6 | 9 | 2 | 1 | |
| | 1838 | 46 | 54 | 51 | 52 | " | 12 | 24 | " | 16 | 76 | 18 | 13 | 9 | 1 | | | |
| FEBRUARY | 1833 | 49 | 60 | 58 | 56 | FEBRUARY | 8th | 37 | FEBRUARY | 28th | 75 | 13 | 15 | 6 | 1 | | | |
| | 1834 | 51 | 66 | 67 | 60 | " | 2 | 31 | " | 22 | 78 | 15 | 13 | 5 | 4 | 1 | | |
| | 1835 | 37 | 51 | 50 | 46 | " | 8 | 12 | " | 21 | 74 | 19 | 9 | 6 | 8 | 1 | 1 | 1 |
| | 1836 | 48 | 63 | 56 | 56 | " | 2 | 30 | " | 21 | 74 | 15 | 14 | 7 | 5 | 1 | | |
| | 1837 | 44 | 58 | 55 | 52 | " | 18 | 29 | " | 15 | 70 | 14 | 14 | 7 | 5 | 1 | | |
| | 1838 | 35 | 47 | 44 | 42 | " | 16 | 12 | " | 25 | 68 | 15 | 13 | 5 | 9 | 1 | | |
| MARCH | 1833 | 51 | 63 | 59 | 57 | MARCH | 2d | 28 | MARCH | 19th | 73 | 12 | 19 | 12 | 1 | | | |
| | 1834 | 55 | 67 | 63 | 62 | " | 1 | 37 | " | 25 | 80 | 11 | 20 | 9 | 2 | 2 | | |
| | 1835 | 48 | 64 | 60 | 57 | " | 1 | 30 | " | 31 | 80 | 15 | 16 | 7 | 4 | | 1 | 1 |
| | 1836 | 50 | 63 | 58 | 57 | " | 3 | 32 | " | 16 | 80 | 19 | 12 | 6 | 5 | | | |
| | 1837 | 52 | 63 | 60 | 58 | " | 15 | 38 | " | 28 | 78 | 15 | 16 | 9 | 2 | | | |
| | 1838 | 54 | 68 | 62 | 61 | " | 8 | 32 | " | 31 | 83 | 20 | 11 | 4 | 4 | | | |
| APRIL | 1833 | 61 | 75 | 68 | 68 | APRIL | 18th | 52 | APRIL | 23d | 85 | 18 | 12 | 4 | | 1 | | |
| | 1834 | 60 | 74 | 69 | 67 | " | 7 | 48 | " | 30 | 84 | 20 | 10 | 10 | | 5 | | |
| | 1835 | 56 | 70 | 65 | 64 | " | 6 | 43 | " | 23 | 80 | 17 | 13 | 7 | | 3 | | |
| | 1836 | 63 | 74 | 69 | 69 | " | 22 | 53 | " | 26 | 82 | 22 | 8 | 8 | | | | |
| | 1837 | 57 | 68 | 64 | 63 | " | 8 | 38 | " | 29 | 80 | 18 | 12 | 8 | | | | |
| | 1838 | 65 | 77 | 68 | 70 | " | 18 | 51 | " | 27 | 84 | 22 | 8 | 6 | | | | |
| MAY | 1833 | 69 | 80 | 74 | 74 | MAY | 5th | 63 | MAY | 27th | 87 | 15 | 16 | 14 | | | | |
| | 1834 | 65 | 77 | 74 | 70 | " | 8 | 50 | " | 28 | 88 | 19 | 12 | 6 | | | | |
| | 1835 | 68 | 80 | 76 | 75 | " | 2 | 58 | " | 30 | 86 | 28 | 3 | 3 | | | | |
| | 1836 | 68 | 78 | 73 | 72 | " | 28 | 58 | " | 30 | 86 | 17 | 14 | 10 | | | | |
| | 1837 | 64 | 81 | 72 | 72 | " | 16 | 51 | " | 30 | 86 | 22 | 9 | 6 | | | | |
| | 1838 | 63 | 73 | 68 | 69 | " | 24 | 50 | " | 14 | 85 | 20 | 11 | 9 | | | | |

(To be continued.)

A writer in the Boston Atlas, maintains, with great force of argument that a low rate of fare on railroads is the best for the stockholders as well as for the public. The eastern railroad, from Boston to Salem, commenced operations with a low rate of fare, and the consequence is, it is doing better than any other railroad in Massachusetts. It is earning ten per cent, per annum. It is said to carry more passengers into Boston than all other railroads which come into the city.

The Boston and Worcester railroad is also mentioned in illustration of the position of the writer. At about the commencement of the present year the fare of this road was reduced from \$2 to \$1 50, and since the reduction, the nett income of the road has been greater than it was before.

It is stated that a train of cars can be run for \$1 per mile; and of course it would cost but little more to carry 200 passengers than it would 50. Hence by reducing the fare, the number of passengers be increased to a degree greater than the degree of reduction in fare, most certainly the proprietors of a road are gainers by the change.

The public will travel vastly more if the rate of fare be low, than if it be high. If a man could go to Boston from a given place for \$2, he would be likely to go twice; when if it cost him \$3, would go but once.

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

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ON THE ADHESION OF THE WHEELS OF LOCOMOTIVE ENGINES, BY W. R. CASEY CIVIL ENGINEER. SEPT. 1839.

Powerful locomotive engines will seldom be required for passenger-trains, and, up to this time, the quantity of freight carried over any railroad in the Union, as far as I can ascertain, falls short of 100,000 tons per annum, whilst the average, according to De Gerstner, is only 15,000 tons carried over each railroad in the country. This is about the one hundredth part of what can very well be done on a well located railway with a single track.

We may however confidently expect that railways will very soon be used for the transportation of freight on a scale sufficiently extensive to prove their capacity for this object. As yet there can be little danger in asserting, that there is not a railroad in the country, which has been located, constructed, and subsequently managed, so as to be even tolerably well adapted to the transportation of a large quantity of freight. The Reading railway will be first in the field to show the power of this new means of communication, and it would be difficult to find a better champion for the cause of railroads. On the Reading road there is, however, no ascending grade in the direction of the greatest trade, and the common 8 or 9 tons engine will easily draw 150 to 200 tons on a level—the greatest reistance offered with the admirable grades of that road; but, where inclinations of from 40 to 60 feet per mile are to be surmounted, engines of that weight are utterly inadequate to the task, whilst heavier or more powerful ones require a more substantial and consequently more costly superstructure.

The question then naturally suggests itself—cannot the power of the engine be increased without an increase of weight? which again immediately leads us to consider, what it is which limits the power of the locomotive steam engine. This is well known to be the friction, or, as it is generally termed, "the adhesion" of the wheel to the rail, which all good engines

built during the last 4 or 5 years have been able to overcome; that is, where the load was sufficiently great, to make the driving wheels revolve without causing the engine to advance. Strange as it may appear, no experiments have yet been made to determine this all important point, and the "friction of iron on iron" given in treatises on mechanics, as equal to about 1-4 of the weight, has been hitherto used in all *calculations* as the maximum, though numerous well authenticated *performances* have shown, that the ratio of the adhesion to the weight must have been much greater than this. In a pamhlet written so late as last year (1838) Messrs. Knight and Latrobe, speaking of a performance of the Stonington locomotive (p. 15,) which showed the adhesion to be equal to $\frac{1}{4 \cdot 55}$ of the weight, say "As this is greater than we have known in any other case, it is presumed that a portion of the weight of the tender was transferred to the engine etc; but performances of the engines of Baldwin and Norris on the Philadelphia and Columbia railway, long before this pamphlet appeared, go very far beyond this.

In 1836, engines built by Mr. Norris, not exceeding 8 tons in weight, drew loads equal to 400 tons on a level, which, if the weight on the driving wheels was correctly given, showed the adhesion to exceed 1-3 of the weight. Mr. Baldwin's engines have, however, since exceeded even this, and have drawn loads equal to above 700 tons on a level. Estimating the traction at 10 pounds per ton, this will require a force of 7000 pounds, and the weight on the driving wheels of Mr. Baldwin's first class engines being stated at 12,120 pounds, the adhesion must have been equal to $\frac{1}{1 \cdot 73}$ of the weight, if this did not exceed 12,120 lbs. or even adding 4000 pounds for the tender, equal to $\frac{1}{2 \cdot 3}$ of the insistent weight.

After making every reasonable deduction, it appears beyond all doubt, that the adhesion has been very much underrated, and, though this alone keeps the power of locomotives within their present range, I have never heard of a single direct experiment to determine this important law. In the edition of '31 of Wood on railroads the adhesion is stated at 1-12, subsequently it is assumed by Mr. Knight at 1-8, or "half the friction of iron on iron," which value was not determined by experiment but was merely deduced from the load; so again in the pamphlet already referred to, as late as last year, $\frac{1}{4 \cdot 55}$ is "greater than we have known in any other case."

Since writing the above, I have seen the experiments of M. G. Rennie on friction, as detailed in the 5th vol. of the Journal of the Franklin Institute, 1830, and he there shows, that there *is* an increase in the ratio with the increase of weight, the surfaces in contact remaining the same. The extreme weights in 11 experiments [p. 9,] are 1·66 cwt. and 5 cwt. per square inch, and, with these pressures, the ratios of the weights to the adhesion are respectively as 4 and 2·44 to 1. The results of the experiments are

very irregular, and, though in this particular case the ratio varies very nearly as the square roots of the weights, there is nothing to point out the law of increase, so as to enable us to continue the table with any confidence.

On the next page [10] it is stated that with 6·5 cwt. per square inch, cast and wrought iron abrade, and the friction is to the weight as 1 to 2·3. Now, as the weight on the driving wheels is generally 2 1-2 tons on each, as the friction of wrought iron on wrought iron is greater than on cast iron, as this difference is rendered the greatest possible by the parallelism of the fibres of the tire and rail, and as the surfaces in contract can scarcely be 1-4 of a square inch,it is evident, that the power required to produce motion,when the pressure is 2 1-2 tons on a surface of much less than 1 inch square, must be more than $\frac{1}{2{\cdot}30}$ of the insistent weight. It is stated, [p. 10,] that hardened steel abraded with 10 tons per square inch, but the ratio of the power to the weight is not given.

The laws of friction, are however, only applicable as long as no abrasion takes place, and this falls very far short of the case under consideration, where the pressure is often sufficient to cause even hardened steel to abrade. Still these experiments and numerous performances of the engines of Baldwin or Norris would lead to the conclusion, that the adhesion is at least twice as great as that which Messrs. Knight and Latrobe designate as "greater than we have known in any other case."

The most interesting performances of locomotives which have fallen under my observation are those detailed in the Franklin Journal of June 1839, where an engine on 8 wheels, constructed by Messrs. Eastwick and Harrison, *started*, on a grade of 27 feet per mile, a load of 265 tons, subsequently overcoming with the same load, a rise of 35 feet per mile. This took place on the bad and crooked road between Broad street and the Schuylkill bridge, where the traction must have been 10 pounds per ton on a level, and the entire force exerted by the engine equal to 6600 pounds. In this engine there are *four* driving wheels, on which the weight was 18,059 pounds, showing thus, that the adhesion was equal to 1-3 of the weight even *with the wheels coupled.* The weight on the driving wheels of Baldwin's engines of the first class, is 1-3 greater than on *one* pair of driving wheels of the engines of Messrs. E. and H., and any sudden lurch of the engine which, with the ordinary construction, will throw more than half its entire weight on one wheel, will, with these engines, be distributed on two wheels, and there can be little doubt, that an engine with the usual weight on 2 driving wheels, will be more injurious than one with twice that weight on four drivers, as arranged by Messrs. E. and H. Here is an engine which will with ease, draw 100 tons nett, up an ascent of 60 feet per mile, and which requires, on *that* inclination, a superstructure no more substantial, than is required by the lightest engines of Baldwin or Norris, on roads varying from a level to 20 or 30 feet per mile—*and this too with anthracite fuel.*

In the interesting pamphlets of Messrs. Knight and Latrobe, already referred to, those gentlemen state that the Camden and Amboy "Company is now building, and have nearly completed, an engine upon eight wheels, and having two cylinders of 18 inches diameter by a 3 feet stroke; the whole supposed to weigh 18 tons." * * * * "The adhesion upon the rails of all the 8 wheels, is to be brought into action by means of cog-wheels etc. etc. * * "This engine is designed to lead burthen trains at moderate rates of speed; but must be viewed as yet in the light of an experiment."

It is difficult to conceive how such, in other respects, keen observers could pass by with cool indifference the most striking fact related in either of their interesting pamphlets and which, even without being completely successful, would be attended with results infinitely more important than the benefits resulting from all American improvements in railroads and locomotives united. In illustration, not explanation, it may be proper to observe, that of all the engineers and machinists with whom I have conversed for the last 2 or three years on this subject, I have only found two engineers [the machinists would not listen to it] who had given the subject that serious attention to which it is, in my humble opinion, pre-eminently entitled. One of these gentlemen, Mr. H. R. Campbell, of Philadelphia, showed me, nearly 3 years since an engine on 8 wheels and 4 drivers, which he was then building to burn anthracite coal, and which certainly bore an astonishing resemblance to the drawings of Messrs. Eastwick and Harrison's engine in the Franklin Journal, and to the advantages of which I have already alluded.

We have seen that with the eight wheeled engine and 4 wheels coupled, the adhesion was equal to 1-3 of the weight on the propeling wheels and if, with the 18 tons engine of Messrs. Stevens, we suppose the adhesion equal to only 1-4 of the weight, we shall have a machine capable of drawing 1000 tons on a level, without greater injury to the superstructure than the ordinary 8 or 9 tons engines of Philadelphia, Baltimore, New York, Lowell, etc. An eight wheeled engine, weighing ten tons, acting by the adhesion of its entire weight distributed equally on the eight wheels, will draw 90 tons nett up an ascent of sixty feet per mile, and there will be no inducement to lessen this weight, as it is only 1 1-4 tons per wheel, or the same as that on each wheel of an ordinary freight or passenger car, when loaded.

It is well known, that the rapid destruction of wooden rails is not caused so much by the natural decay of the timber consequent on its exposed situation, as by the crushing under the driving wheels of the locomotive, which destroys the lateral cohesion of the fibres of the wood and admits water, the grand agent of decomposition. Notwithstanding this disadvantage, the repairs of the wooden track of the Utica and Schenectady railroad, do not exceed the repairs of the best roads about Boston, (from 300 to 350 dollars per mile per annum, the renewal of the iron being neglected in both cases) and, if an engine of 10 tons will not be more injurious to the superstructure, than an ordinary car, it may yet appear, that this improve-

ment *alone,* will reduce the repairs and renewals of the common superstructure, below those of the best road in the Union, omitting the assistance which may reasonably be expected from Kyan's or some other mode of preserving timber.

It has frequently happened, that horse power has been used for a short time after the opening of a road, by which the nice adjustment of the rails as received from the hands of the engineers, has been little if at all affected. After the road has been travelled by the engine, however, even for a single week, with the very same cars, depressions and inequalities will be found greater, as well as more numerous than those which would be produced by the action of the *cars* only in six months or more. Timber as well as iron will bear a certain strain without the least injury, but a slight increase beyond this, produces a permanent "set" or deflection, hence, in reducing the weight from 2 1-2 to 1 1-4 tons per wheel, the relative strength of the superstructure is not merely doubled, but is increasedin a much greater ratio. This proportion will be affected by the dimensions of iron and timber, kind of wood, arrangement of parts, nature of earth, etc. etc., but as a general rule it will be greatest where most needed—for instance, when a light superstructure is bedded in clay, in a northern climate.

The distribution of the weight of the engine on eight wheels, instead of throwing 3-5 or more on 2 wheels, is therefore intimately connected with the continuance of a cheap superstructure, which has been, and will be, even with the present engines, extensively used in many parts of the country, where capital and good mechanics are scarce and timber and axemen abundant. Owing to the increased deflection of the wooden rail there will of course be a loss of power, but this, even now not very important, will be reduced one half by the distribution of the weight on all the wheels, besides which the only fear is, that full loads will only too seldom be obtained for the lightest class of engines, built on this principle, even with grades of from forty to sixty feet per mile.

I have been informed by my friend Mr. E. F. Johnson (the other engineer alluded to in a preceding paragraph) that a trial of this new engine has been made and that it appears to work well. Time and experience can however alone develope its powers, expose its defects and give unerring proof of its general and successful adoption. But supposing, what is most unlikely, that this experiment should lead to no useful result, we have still the eight wheeled engine of Messrs. Eeastwick and Harrison (or Mr. H. R. Campbell ?) which is capable of drawing 100 tons nett up an inclination of sixty feet per mile, and which will be less injurious to the superstructure than the ordinary eight or nine tons English or American engine.

An extremely interesting and still more useful experiment may very easily be made with the engine of Messrs. E. & H., or still better, with that of the Messrs. Stevens. Remove the couplings so that the engine may act by the adhesion of one pair of wheels only, and ascertain the maximum

load without slipping the wheels; then couple two pair of wheels, repeat the experiment and the increase of load will show the value of the improvement of Messrs. E. & H. With the eight wheeled engine, four such experiments should be made, by which the advantages of this mode of construction would be determined with considerable accuracy, and all requisite information afforded on this vital, and hitherto much neglected principle, of working by the adhesion of more than two wheels.

The successful introduction of engines with the weight distributed equally on, and acting by the adhesion of eight wheels, would form an era in the history of railways in the United States, second only, to that which determined the general question of the practicability of locomotion by steam—in other words, that which gave its present importance to this unrivalled mode of communication.

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West Haverford, Del, Co. Penn.<br>September 12th, 1839.

For the American Railroad Journal.

Having been employed on the Columbia and Philadelphia railway during its construction, a great many notes relative to the character and cost of the different portions of the work, accumulated in my possession.—Taking advantage of some leisure time this summer, (the first that has occurred since the completion of that work) I have arranged these notes for my own satisfaction, and have added some statements relative to the subsequent operations upon the road. The object being merely to give a correct statistical account, I have abstained from giving expression to any opinions or speculations as to the character or merits of the work. In making comparisons of the performances on different railways, I have often felt the want of correct information as to the important features of the roads in question.

Under the impression that the same might be the case with others, I have thought the annexed account might not be uninteresting to your readers. Should you agree in this opinion it is at your service for publication.

Respectfully yours.

W. H. Wilson.

### Columbia and Philadelphia Railway.

This railway commences at the corner of Broad and Vine streets, in the City of Philadelphia, and terminates at the burrough of Columbia on the Susquehanna river, the length being 81 6-10 miles. It has been constructed and is still owned by the State of Pennsylvania.

In the year 1827, surveys of the route were made by direction of the Legislature, and on the 24th of March 1828, the construction of the railway was authorised as a State work. The location was commenced immediately after, and early in the year 1829 the grading and bridging of 40 miles of the road were put under contract; different portions of the work were successfully contracted for, according to the yearly appropriations made

for that purpose. On the 20th September, 1832, twenty miles of single track were opened for travelling; in April 1834, a single track was completed throughout, and in october of the same year, both tracks for the entire length of the road were open for public use. Much incidental work was however done after that time, the buildings for depots, workshops, &c. being in an unfinished state and some turn-outs, farm bridges &c. not con structed.

Major John Wilson had charge of the operations on this line as Chief Engineer, from the commencement of the preliminary surveys, until a short time previous to his death in the spring of 1833, after which time the work was placed under the direction of Edward F. Gay, Esq. The following description will afford some general idea of the prominent features of this railway. From Broad street the line takes a northwesterly course passing near the Fairmount water works, and from thence runs nearly parallel to the Schuylkill river, which it crosses at the distance of about three miles from the city, the grades being undulating to conform to the inclinations of the streets which are crossed. Immediately west of the river is an inclined plane of 2805 feet in length and 187 feet in height; this plane is straight and its inclination uniform. From the head of the inclined plane, the line is continued on the dividing ridge between waters flowing into the Delaware and the Schuylkill, for about 19 miles, to a point near the intersection of the West Chester railway, where it attains an elevation of 543 feet above high tide; the grades on this portion of the road are varied and undulating, but generally ascending westward. The road now descends the northern slope of the South Valley hill into the Great Chester Valley, and after crossing Valley creek, comes to the East or Big Brandywine at Downingtown; for nearly the whole distance [about 11 miles] the descent is at the rate of 29 feet per mile. The hight of railway above high tide at Brandywine bridge is 250 feet. From East to West Brandywine, a distance of about 7 miles, the grades are generally ascending, the whole rise between those points being 121 feet. After crossing the West or Little Brandywine near Coatesville, the line ascends the Southern slope of the North Valley hill until it reaches the summit of the Mine ridge at the Gap. According to the first location, an excavation of 37 feet was required at this point, but upon removing a few feet of the surface, the material below was found to be quicksand; after losing a great deal of time, and incurring heavy expense, in efforts to work down this cutting, it was deemed advisable to raise the grade so as to reduce the depth of excavation to 23 feet; in consequence of which, the grade now stands at 45 feet per mile, descending each way from the summit for three foruths of a mile and then at 40 feet per mile for one fourth of a mile, when it meets the original inclination of 30 feet per mile. The Gap summit is 553 feet above high tide at Philadelphia. From this point the road descends, and after crossing Pequea creek, Mill creek, and Big Conestoga, enters the city of Lancaster; leaving which, it is conducted across Little Conestoga, towards the head

of the inclined plane at Columbia. This plane is 1800 feet in length and 90 feet in height; it is straight and its inclination uniform. From the foot of the plane the road continues along the margin of the river Susquehanna in front of the town, to the outlet lock and basin of the Pennsylvania Canal. It is graded along the edge of the basin, sufficiently low for the convenient transfer of articles from one mode of conveyance to the other. The passage of a law to authorize the construction of this railway by the Commonwealth, met with serious opposition, and even after the work had been commenced, it was for some time a matter of doubt whether opperations would not be suspended. Under these circumstances, it was the earnest desire of the friends of the road, that as much economy should be used in the construction, as was consistant with a due regard to the utility of the work, when completed. Previous to commencing the location, it became necessary for the Engineer to determine upon its governing principles, and in order to establish these, recourse was had to the experience gained upon works of a similar kind already in operation. It must be recolleted that this was in the year 1828, previous to the opening of the Liverpool and Manchester railway, when there were but few railways of any extent in use, and those of very imperfect construction. It was also prior to the successful use of Locomotive engines; it is true that these machines were then operating upon some of the English railroads, but their use was attended with so many objections, that very few were sanguine enough to anticipate their general adoption. After the most mature consideration of the subject, the maximum grade of the Col. and Phil. railroad was fixed at 30 feet per mile and its minimum radius of curvature at 631 feet, these being the limits to which it was thought prudent to go, with an eye to economy of construction on one hand, and the useful effect of the road on the other. The principles here laid down have been adhered to with one exception, which is the increase of grade in surmounting the Mine ridge at the Gap; the distance however for which the grade has been raised is so short, that the difference is scarcely felt by trains passing over the road. It may be proper to observe here, that in references made to this railway by companies prosecuting rival works, or by others interested in representing it in the most unfavorable light, the minimum radius of curvature is stated at 300 feet; there is a curve of this radius 7 chains in length at the termination of the road, but it is in the streets of Philadelphia, beyond the point at which the Locomotive engines are stopped and the trains separated, and ought no more to be taken into view when refering to the road, than ought the numerous abrupt curves through the Northern Liberties to be considered as parts of the Trenton Railway. The inclined planes on this road being a source of expense and delay to the transportation, every possible effort has been made to avoid them. A new route of six miles in length has been located, and is now nearly completed, by which the plane at Columbia will be dispensed with; the distance is about the same as the part of the old line to be abandoned, and the grade 35 feet per mile. Several routes have

been surveyed for the purpose of avoiding the inclined plane near Philadelphia, but as yet no alteration has been adopted by the States, two roads have been commenced by chartered companies for this purpose. The West Philadelphia railway is about 8 miles in length, its maximum grade 57 feet per mile, and its average grade 43 3-10 feet per mile; the grading of this road is principally done, but the work is now suspended for want of funds. The other route is by the Valley and Norristown railroads; the distance by Valley road is 20 1-4 miles, and then by Norristown road 13 1-2 miles, making a total of 33 3-4 miles or 2 1-8 miles more than the portion of the State road to be avoided; the maximum grade of the Valley road is 35 7-10 feet per mile, and of the Norristown 37 4-10 feet per mile; the latter road is graded for two tracks, and has one track now in use; on the Valley road the grading is partly done. On no other route yet surveyed for avoid- this plane is the grade less than 40 feet per mile.

The following is a summary of the straight lines and curves on the Col. and Phil. railway.

| | Miles. | Chains. | Links. |
|---|---|---|---|
| Straight line, | 56 | 62 | 54 |
| Curve of 3782 ft. radius, | | 75 | 25 |
| " " 1981 " " | 5 | 24 | 16 |
| " " 1513 " " | | 57 | 00 |
| " " 1260 " " | 6 | 16 | 73 |
| " " 968 " " | | 8 | 42 |
| " " 946 " " | 6 | 20 | 04 |
| " " 841 " " | | 9 | 67 |
| " " 757 " " | 3 | 61 | 29 |
| " " 631 " " | 1 | 25 | 95 |

*Grading.*—The width of road is 25 feet in the excavations, and by the original design it varied on the embankments from 22 to 25 feet, according to the supply of material, but at this time the top width of embankments generally exceeds 25 feet. The deepest cuttings on the line are between 30 and 40 feet, and the lightest embankment is 80 feet.

*Inclined planes.*—The inclined plane at Schuylkill river is 2805 feet in length and 187 feet in height; at the head of the plane is a building composed of two wings built of stone, connected by a wooden structure over the roadway. Each wing is calculated to hold a stationary steam engine of 60 horse power; only one. however, has been put up. The rope is an endless one, of 9 inches circumference when new, and cost about $2,800. The first rope used was 6 3-4 inches in circumference, cost $2,100, weighed 5 1-4 tons, and lasted about one year. The inclined plane at Columbia is 1800 feet in length, and 90 feet in height. The engine house at head of plane is built of brick, and designed to accommodate two steam engines of 40 horse power each, one of which is put up. On both of these planes double tracks are laid, and cars are passed up and down at the same time.

*Culverts.*—The culverts are all built of stone, and the masonry is either

hammer dressed or rubble work; they are 75 in number, with spans varying from 4 to 25 feet, and contain 31,161 perches of masonry.

*Bridges.*—The number of railway bridges or viaducts is 22; they are constructed with stone abutments and piers, surmounted by wooden structures, and contain 61,425 perches of masonry, and 7,212 lineal feet of wooden platform. Two of these bridges supported on small stone piers and wooden trestles, have lately been replaced by embankments. There are 33 bridges across the railway for public and private roads. The following are the most important viaducts.

*Schuylkill viaduct.*—The superstructure is composed of wood, with four distinct trusses, formed of arch pieces, king posts, and braces, being a modification of Burr's plan. The whole width from out to out, is 49 ft. 8 inches, which admits of three separate passages, two of 18 1-2 feet each, in the clear, and one of 4 ft.; the latter is intended for foot passengers, one of the former for two railway tracks, and the other for common carriages. The spans are seven in number, and their lengths in clear, between the piers are as follows; two of 122 feet each, three of 135 ft. each, and two of 137 ft. each. The eastern abutment and four piers are founded upon solid rock; the remaining abutment and piers, upon hard gravel. The masonry is coursed and hammer dressed. Five of the piers were built in the river, and required coffer dams; one of which stood in 26 feet depth of water. The whole length of wooden platform is 1,045 feet, and the number of perches of masonry 19,100. The height of bridge floor above the usual water line, is 38 feet. The total cost including painting inside and outside, was $133,946 57.

*Valley Creek viaduct* consists of 4 spans, each 130 ft. in clear between the piers. The piers are built of rubble masonry, and vary from 56 to 59 feet in height. The original structure was on Burr's plan, having two trusses with a clear width of 18 1-2 feet, and cost, including stone work, $22,254 21. The wood work was destroyed recently by fire, and replaced by a lattice bridge (lowered so as to admit of the railway being carried over the top,) at a cost of $17,218 13.

*East Brandywine viaduct* has four spans, two of 88 feet 8 inches each, and two of 121 feet 7 inches each in the clear. The superstructure is on Burr's plan with a clear width of 18 1-2 feet. The whole length of platform is 477 feet, and the height of floor above water in creek 30 feet. Cost $17,523 20.

*West Brandywine viaduct* has a wooden superstructure; resting upon abutments and piers of coursed masonry with rustic faces, commonly denominated rock work. The length of the bridge platform is 835 feet, divided into six spans; its greatest height above the water is 72 feet. The whole cost of stone and wood work is $57,916 00. The plan is similar to that of the bridge over East Brandywine, except that the superstructure is lowered for the railway to pass over its top. This and the new bridge at

Valley Creek, are the only two of the principal structures, on this line, in which the usual form of roof is dispensed with.

*Pequea viaduct* is a single span of 130 feet, on Burr's plan, and cost $8,735 50.

*Mill Creek viaduct* is built on Burr's plan; the whole length of wooden platform is 550 feet, and its greatest elevation from the water 40 feet. Cost $9,273 18.

*Big Conestoga viaduct* is 1,412 feet in length, and is elevated 60 feet above the water. The piers are built of rubble masonry, and the superstructure is lattice work on Town's plan. Whole cost $31,503 57. The longest span of this bridge is 120 feet.

*Little Conestoga viaduct.*—The piers are built of rubble masonry and the wood work on Burr's plan. The flooring is 804 feet in length, and is elevated 47 feet above the water of creek. Cost $15,359 00.

*Railway superstructure.*—The length of road being, as before stated, 81 6-10 miles, there are 163 2-10 miles of single track; of which 6 miles are laid with granite sills plated with flat iron bars, 18 miles with wooden string pieces plated in a similar manner, 2 miles with stone blocks and edge rails, having stone sills extending across the track at every 15 feet, and 137 2-10 miles with stone block and edge rails, [having wooden sills extending across the track at intervals,] except on some of the embankments, where the edge rail is secured to cross sills of wood, supported by mud sills.

*Granite Track.*—The trenches are dug in the direction of the road, two feet in width, and 22 inches in depth, measuring from the level of top of sill. Broken stone is then placed and compacted in layers of 3 inches each. Upon this are laid granite sills varying in length from 3 to 12 feet, and one foot in depth and width. Holes are drilled into the stone [to correspond with the holes in the bars, and to suit the width and position of the track] 3 1-2 inches in depth, and 5-8 of an inch in diameter. Into these holes, plugs of locust wood are driven, to receive the spikes which secure the iron bars, which are 15 ft. in length, 2 1-4 inches in width, and 5-8 of an inch in thickness. The inner edge of the sills, is champered off for a width of 2 inches, and the outside is backed up with broken stone. Horse power being used on the road when this track was laid, a horse path was formed of broken stone or gravel 6 inches in depth. The average cost for one mile of this track, including the trimming and dressing off half the width of roadway was $10,179 20.

*Wooden Track.*—The trenches are dug across the road, four feet apart, 8 feet in length, one foot in width, and 16 inches in depth [making 24 inches to top of wooden rail.] Into these, broken stone is rammed in layers, upon which are laid sills of chestnut or white oak, 7 1-2 feet long and 7 inches square. The sills are notched to receive a yellow pine string piece 6 inches square, which is secured in its place by wooden wedges. Flat

iron bars are then spiked on similar to those used on the granite track; the horse path is also similar. This track cost $5,604 48 per mile.

The two kinds of superstructure just described, have been in use on this road about seven years, but during the last year, they have been travelled over only by a few cars drawn by horses, being so much out of order as to be unsafe for locomotive engines. The wooden sills and string pieces have become decayed, and in both cases the iron bars are constantly working loose. In many places these bars have been broken or split by the heavy weights passing over them, particularly on the stone track. It is intended to renew this portion of the road with edge rails; a short distance has already been done.

*Edge rails on stone blocks and sills.*—The trenches are dug in the direction of the road, 28 inches wide, and 24 inches deep, [from top of block;] at every 15 feet these are connected by a cross trench 16 inches wide. Broken stone to the depth of 12 inches, is well rammed in layers; the blocks and sills are then settled in their places by heavy rammers, and backed up to their tops with broken stone. The blocks are of granite or other hard stone, 20 inches long, 16 inches wide, and 12 inches deep; the sills are of the same material, 6 1-2 feet in length, and one foot square, placed across the track at every 15 feet; the blocks are so arranged as to give a support to the rails at every 3 feet. Cast iron chairs weighing 15 lbs., are secured to the blocks and sills, by bolts driven into cedar plugs previously inserted into the stone; there are two bolts to a chair, weighing 10 ounces each; between the stone and chair, a piece of tarred canvass is inserted. The rails are of rolled iron, 15 feet long, 3 1-2 inches deep, parallel at top and bottom, and weigh 41 1-4 lbs. per lineal yard. The rail is secured in the chair by two wrought iron wedges, one on each side, weighing 10 oz. The horse path for this track is formed of broken stone and gravel 9 inches deep. Average cost of one mile $12,568 85.

Several miles of track were laid in a similar manner to the above, omitting the stone sill, and substituting in its place two blocks, at a cost of $10,927 88 per mile. This kind of track was found so liable to spread, particularly in the spring of the year, when the ground was soft, that wooden sills have since been put in at intervals, connecting the two rails of the track.

*Edge rails on stone blocks and locust sills.*—This kind of track is similar to the edge rail track already described, with the following exceptions; instead of stone sills, locust are used, placed 15 feet apart on the streight lines, and 9 feet apart on the curves; to suit which, some bars were rolled in lengths of 18 feet; the stone horse path is dispensed with, the tops of the blocks and sills being level with the graded surface of road. The average cost of one mile on this plan is $13,240 92; the excess over the cost of the track where stone sills were used, is owing to a rise in the cost of iron, from $41 to $50 per ton [delivered in Philadelphia.] On newly formed embankments the following plan was adopted; longitudinal trenches were dug, 22 inches wide, and 22 inches deep; broken stone to the depth of 6 inches,

being rammed in, string pieces of white oak or chestnut were laid, 12 inches deep by 10 inches wide; these being notched to the depth of 2 inches, cross sills of the same material, 6 by 8 inches, were secured to them at every 3 feet by pins or wedges. On these sills the iron chairs, rails, etc., were placed. The trenches were connected at intervals, by cross trenches, running out to the edge of the embankment, for the purpose of carrying off any water which might collect. This description of track cost $12,905 35 per mile. This road having been designed and constructed with a view to the use of horse power, a system of turn-outs and side tracks was adopted with particular reference to that kind of travelling. Turn-outs were placed at intervals from one track to the other, and side tracks were constructed, adjacent to each of the main tracks, at the distance of one mile and a half apart, for the whole length of the road; these side tracks measured as follows; 160 feet in length parallel to the main track, and 70 feet at each end, curved to the intersection with outside rail of main track. They afforded a space of about 200 feet in length for cars, and as the cars always entered in the same direction after both tracks were completed, only one moveable switch was used. The castings were according to J. Elgar's plan, and were made under his direction. Upon the introduction of steam power upon the road, the numerous castings were found very objectionable, and useless; nearly all of them were consequently taken up, and most of the side tracks were also removed. Wherever it has since been found necessary for the accommodation of business to have turn-outs or crossings, new castings have been made use of, better adapted to the present mode of travelling.

The branches connected with this railway which have been completed for use are, the West Chester railway 10 miles in length, interseting about 22 miles from Philadelphia, and the Harrisburg railway 40 miles in length, connecting at Lancaster 12 miles from the western extremity. On the former of these roads, horse power is used; on the latter, steam power;—both belong to chartered companies. The following table exhibits the cost of the Columbia and Philadelphia railway as nearly as can be ascertained. From the commencement of the work to the time of its being opened for public use, the gross amount of the appropriations for purposes of construction could easily be obtained; but since that period various sums have been appropriated yearly to this road, some of which properly belong to the item of construction, while others have been applied to objects not connected therewith.

All the documents relating to this subject have been carefully examined and the result is believed to be as correct as can possibly be obtained.

TOTAL COST OF COLUMBIA AND PHILADLPHIA RAILWAY.

| | |
|---|---|
| Grading, | $649,158 69 |
| Culverts, | 74,113 94 |
| Railway bridges or viaducts, | 327,695 80 |
| Road and farm bridges, | 42,055 00 |
| Fencing, | 65,410 86 |

| | |
|---|---|
| Railway superstructure, | 2,181,156 25 |
| Buildings and machinery, | 111,787 12 |
| Engineering and superintendence, | 133,934 31 |
| Damages, | 54,833 29 |
| Repairs, | 42,451 76 |
| Incidental, | 11,980 18 |
| Alteration to accommodate the city of Lancaster, | 60,000 00 |
| | $3,754,577 20 |

Cost when the road was open for use in 1834; after which, the following additional expenditures were made.

| | |
|---|---|
| Locomotive engines, | 327,203 41 |
| Additional buildings, turn-outs, &c., | 37,511 16 |
| Retained per centage on old contracts, | 5,134 08 |
| Engineering, | 4,741 25 |
| New ropes at inclined planes, | 11,584 34 |
| Embankment at Maul's bridge, | 1,796 34 |
| Renewal of wooden track, | 18,907 48 |
| Rebuilding Valley creek bridge, | 17,218 13 |
| New road to avoid Columbia inclined plane, | 118,123 53 |
| | $4,296,796 92 |

The following particulars in relation to the working of the Columbia and Philadelphia railway, are compiled from the annual reports of the officers of the road, up to October 31st 1838, the date of the last report.

| | Road expenses. | Motive power expenses. | Road tolls. | Motive power tolls. | Total expenses. | Total tolls. |
|---|---|---|---|---|---|---|
| | $ cts. | $ cts. | $ cts. | $ cts. | $ cts. | $ cts. |
| From commencement of travel, to Oct. 31 1835. | 41,973 13 | 55,246 27 | 185,560 67 | 43,790 55 | 97,219 40 | 229,351 22 |
| From Oct. 31 '35 to do. '36 | 75,311 32 | 184,878 84 | 173,837 12 | 90,969 12 | 260,190 16 | 264,806 24 |
| " " '36 " '37 | 59,024 95 | 114,859 .76 | 211,324 16 | 137,338 67 | 173,884 71 | 348,662 83 |
| " " '37 " '38 | 44,033 23 | 133,820 90 | 233,588 75 | 164,052 74 | 177,854 13 | 397,641 49 |
| | 220,342 63 | 488,805 77 | 804,310 70 | 436,151 08 | 709,148 40 | 1,240,461 78 |

All the cars used on this road belong to individuals or companies, but the motive power is furnished by the State, except in the case of the West Chester cars and some few others, which are drawn by horses. Every thing connected with the management of the motive power is entrusted to an officer styled "Superintendant of motive power;" the repairs of the road are attended to by a Supervisor; these officers are independent of each other, appoint all persons employed under them, and report annually to the Board of Canal Commissioners on the state of their respective departments. There are five offices for the collection of tolls, the incumbents of which are appointed by the Board of Canal Commissioners. Separate accounts are kept by the collectors, of the tolls received for the use of the road, and for motive power; the latter constitutute a fund, out of which all expenses in that department are paid; for the repairs of the road, yearly appropriatons are made by the Legislature.

The rates of toll for the use of the road vary from 6 mills to 4 cents per ton (of 2000 pounds) per mile; there are 12 different rates, the average of which would be 2 cents per ton per mile. The lowest rates are for coal, stone,

iron ore, vegetables, lime, manure and timber, and the highest are for dry goods, drugs, medicines, steel and furs. On the United States Mail, the toll is one mill per mile, for every 10 pounds; on every passenger one cent per mile. In addition to these rates, a toll is levied, of one cent per mile on each burthen car, two cents per mile on each baggage car, and on every passenger car, one cent per mile for each pair of wheels. The motive power toll is, for each car having four wheels, one cent per mile, for each additional pair of wheels five mills, for each passenger, one cent per mile, and for all other kinds of loading, 12 mills per ton [of 2000 pounds.] The owners of cars now charge $3,25 for every passenger, and $7 50 for every ton of merchandize conveyed the whole length of the road, they paying all tolls: which is at the rate of 4 cents per mile for a passenger, and 9 14-100 cts. per mile for a ton of goods. Taking the length of the road at 82 miles, the average number of passengers to an eight-wheel car at 30, and the load of a four wheel burthen car at 3 tons, we have the following results;

| | |
|---|---|
| Road toll on an eight wheel car, | 4 cents per mile |
| " " 30 passengers, | 30 " " |
| Motive power toll on car, | 2 " " |
| " " 30 passengers | 30 " " |
| Total toll for 30 passengers | 66 " " |

or 2 2-10 cents per mile for each passenger, leaving 1 8-10 cents per mile to the owner of the car for every passenger.

| | |
|---|---|
| Road toll on a four wheel burthen car, | 1 cent per mile |
| " " three tons of dry goods, | 12 " " |
| Motive power toll on car, | 1 " " |
| " " three tons of goods | 3 6-10 " |
| Total toll on three tons of dry goods | 17 6-10 |

or 5 86-100 cents per ton per mile, leaving 3 28-100 cents per ton per mile to the owner of the car.

In making comparisons between the working of this and other railways, the error has generally been committed, of taking the motive power expenses [given in the reports of the State officers] as the whole cost of transportation; it must be recollected, that the State merely furnishes the moving power; the owners of cars have to provide their own workshops, and depots for receiving and depositing goods; they are also obliged to send agents with their cars, and have to take the risk of all accidents. The duty of the State agents who accompany each train, is to rgulate the motions of the train, and to see that proper returns are made to the collectors, of the passengers and freight conveyed.

DETAILS OF MOTIVE POWER EXPENSES FOR THE YEAR ENDING OCTOBER 31ST, 1838.

| | |
|---|---|
| Expended at workshops, | $14,102 05 |
| " " inclined planes, | 16,942 90 |
| Superintendant, clerk, and car agents, | 8,022 00 |
| Car inspectors, | 1,196 00 |
| Conductor of State cars, | 407 50 |
| Engineers of locomotives, | 10,786 00 |
| Firemen, | 6,662 87½ |
| Watermen, | 6,825 00 |
| Woodmen, | 8,212 22 |
| Wood, | 27,889 33¾ |
| Coal, | 10,732 67½ |
| Materials for engines, | 20,720 91¼ |

| | |
|---|---|
| Oil, | 6,568 85 |
| Miscellaneous, | 852 62 |
| | $139,920 94 |
| Add amount of debts contracted, | 5,600 00 |
| | 145,520 94 |
| Deduct stock on hand, fuel, iron, oil, &c., | 11,700 00 |
| | $133,820 94 |

During the same year, the number of passengers conveyed, was 103,336 way and through, equal to 75,612 through; the number of tons of freight transported was 87,180, and the whole number of miles travelled was 260,400.

LIST OF PERSONS EMPLOYED IN MOTIVE POWER DEPARTMENT.

| | | |
|---|---|---|
| Superintendant of motive power, at | $4 00 | per day. |
| Clerk, | 2 00 | " |
| 2 car inspectors, each, | 2 00 | " |
| Manager between Philadelphia and inclined plane, | 2 50 | " |
| 4 agents for passenger trains each, | 2 00 | " |
| 5 " " burthen " " | 1 50 | " |
| Conductor of State cars, | 1 25 | " |
| Master Machinist, | 4 00 | " |
| 2 Foremen of workshops, each, | 2 00 | " |
| 18 Machinists, pay varying from 1 00 to | 2 00 | " |
| 9 Smiths, " " " 1 50 to | 1 92 | " |
| 9 Assistants, each, | 1 25 | " |
| Engineer of stationary engine at workshop, | 1 16 | " |
| Watchman, | 1 16 | " |
| 2 Managers at inclined planes, each, | 2 50 | " |
| 2 Engineers " " " | 2 00 | " |
| 2 Firemen " " " | 1 25 | " |
| 2 Riggers " " " | 1 50 | " |
| 11 Signal men, and assistants, " | 1 25 | " |
| 26 Engineers of locomotives, " | 2 00 | " |
| 33 Firemen " " | 1 25 | " |
| 19 Watermen, " | 1 00 | " |
| 33 Woodmen, " | 1 00 | " |

The superintendant in his report dated October, 1837, states as follows: "The heavy locomotives now used for the transportation of freight, are capable of drawing thirty-five cars, each with a load of three tons, or one hundred and five tons, exclusive of the cars, engine, and tender. If their weight be added, the whole will be one hundred and ninety tons" "The average number of cars to each engine, actually hauled during the season, falls far short of the number just given; this is owing to the irregularity and decrease of business which prevailed, and to the rule, which for the accommodation of the trade was adopted, of starting a train whenever one of sufficient size to justify the expense had accumulated, without delaying, and increasing the expense of the transporters by waiting for a full one."

The number of locomotive engines on the road at the date of the last report was thirty-six, of which, twenty-seven were in good order. The daily duty of the engines is to run from the head of one inclined plane to the head of the other, a distance of seventy-seven miles; between the foot of the Schuylkill plane and Philadelphia, a distance of three miles, two engines are generally kept employed in taking the trains to and fro: form the Columbia plane to the canal basin, horse power is used, the distance being only one mile.

**ADVANTAGES OF COMPRESSED PEAT, OR TURF, AS A FUEL FOR STEAM ENGINES, AND IN THE REDUCTION OF IRON ORE.**

From a communication addressed to the London Journal of Arts, Sciences, and Manufactures, by C. W. Williams, it appears that by a compression of the upper portions of peat or turf bogs, and working the condensed material, a compact fuel may be obtained, surpassing, in strength and other good qualities, the best coke obtained from bituminous coal.

The following extract presents the results of the experiments:

In pursuing the inquiry as to the manufacture of turf coke, I fell naturally into the common error of taking the lower portions of the bog in preference to those nearer the surface; and from this circumstance, that the latter, on account of their lightness, appeared wholly unsuited to the purpose; while the former, from their greater comparative density, seemed alone available in producing a coke which could stand the blast. From the lower strata a sufficiently dense coke could be formed, by the aid of suitable coking stoves, but it was found to be so impure, and impregnated with so large a proportion of incombustible and deleterious matter, as to have an injurious effect on iron, from an acid which it was supposed to contain. From the upper strata, and particularly where they were composed of bog moss, which had made but little progress towards decomposition and solidification, I obtain an exceedingly pure carbon, giving a very small per centage of useless, and no injurious, matter. This upper portion of the bog, however, was of so light and porous a texture, and so apt to re-absorb moisture, by which its heating properties were much reduced, that it would scarcely repay the labor of cutting and saving, even for domestic fuel, while the lower strata, on the contrary, often approached the solidity of coal. This superior density had been acquired, in some degree, by the decomposition and consequent solidification of its vegetable fibre, but still more, by the consolidation, through ages, from the pressure of the superincumbent mass, often to the depth of twenty or thirty feet. But this great density, valuable as it may be, had been obtained at the expense of its purity and heating properties, by the addition of many heterogenous and incombustible substances; and which, *pro tanto*, and without reference to their chemical effects, deteriorate its calorific power and usefulness as a fuel.

I may here observe, that I have burned the compressed peat coke, which forms the subject of the following analysis, in a small room, in a stove resembling Joyce's stove, standing on the table, for four days and nights successively, during which it was never extinguished, and, without any perceptible unpleasant smell, or other annoyance.

Now, having thus ascertained that the upper and lighter portions of the bog had the greatest purity and heating power, weight for weight, the difficulty presented itself of combining density with purity, and which in the natural state do not co-exist.

In this I have completely succeeded, having obtained a coke, from the lighter portions of the bog, possessing not only double the density of wood charcoal, and equal to that of coal coke, but possessing that purity which is so essential in the working of iron. To ascertain the relative values of the compressed peat, and peat coke, as compared with coal, coal coke, and charcoal, I had a very accurate analysis made by the able experimenter, Mr. Everitt, and whose report I here subjoin:

*Report of Experiments on Pressed Peat, and on Coke made therefrom.*

| | |
|---|---|
| DENSITY.—The density or specific gravity of water, | 1000 |
| Compressed peat, the the thinest and hardest pressed, | 1160 |
| Ditto, the thicker, or less pressed, | 910 |

| | |
|---|---|
| Peat coke, the thinnest or hard pressed, | 1040 |
| Ditto, the thicker or less pressed, | 913 |
| The resin fuel, | 1140 |
| The resin alone, | 1110 |
| The hardest and dry woods, such as oak, ash, elm, vary from | 800 to 885 |
| And the lighter woods, such as poplar, pine, &c., from | 383 — 530 |
| Charcoal from hard woods, varies from | 400 — 625 |
| Coals vary from | 1160—1600 |

Hence we see that the hardest compressed peat is denser than the hardest wood, in the relation of 1160 to 885; and compared with some of the lighter wood, nearly double. Further, that the coke prepared from the hardest compressed peat, is nearly double the density of ordinary charcoal. In common practice, it is reckoned that 100 lbs. of charcoal occupy the same space in a measure as 200 lbs. of coke. The peat coke would, weight for weight, occupy the same, very nearly, as common coke.

Calorific Power.—The next point of investigation was the calorific power, as compared to coal, common coke, and charcoal.

The usual method of making assays of this kind, is to burn weighed quantities of the respective fuels, and endeavor to ascertain how much water each respectively will raise a given number of degrees, or convert into vapor. But experiments of this sort, unless made on a very large scale, cannot lead to any comparable results. It is given in Berthier, (Essais par la veie secho, vol. i., p. 289,) as being the result of accurate experiments, that a given weight of charcoal will raise 78 times its own weight of water from 32° to 212°, or boil off in vapor 11 8-10 its weight: which data do not differ materially from the results obtained on a large scale, by J. Parkes, [see his paper in the "Transactions of Civil Engineers," vol. ii., p. 161.] Now we know, from actual trial, that weighed portions of coke, charcoal, &c., used under stills and boilers, holding only from 5 to 10 gallons of water, will not produce 1-10 of this effect. I am here convinced of the utter futility of trusting to any such experiments on a small scale, with the view of having any thing like an approximation to the true relative values of fuel; even in the best constructed calorimeters, where only a pound or so of the fuel is consumed, it is very difficult to command uniformity through any two experiments. I was here induced to adopt the method recommended by Berthier, in his work, vol. i., p. 228, in order to obtain the relative values of these fuels.

It is assumed, from the result of almost all experiments, that the absolute quantity of heat generated, during the combustion of any fuel, is in exact relation to the quantity of oxygen consumed on entering into combination: hence in order to ascertain the relative calorific powers of fuels, it is only necessary to ascertain the quantity of oxygen each consumes in burning.

The best mode of doing this is to mix a weighed quantity of the fuel with a slight excess of litharge, [oxide of lead] and find what quantity of metallic lead is reduced. It is to be remarked, that this method cannot be applied to such fuels as contain any volatile matter, from Berthier, [and which also agreed with some trials made by me on the same substances.]

| | |
|---|---|
| 10 parts of pure carbon will give of lead | 340 grs. |
| 10 parts of good wood charcoal, from | 300 to 323 |
| 10 parts of dry woods, from | 120—140 |
| 10 parts of good coke, from | 260—285 |

It may be here remarked, that assuming the principle, which is the foundation of this mode of assaying, to be correct in practice, it is susceptible of

great accuracy; for, as every *single grain* of carbon produces 34 grains of lead, any error in estimating the lead is reduced to 1-34th in estimating the carbon.

The following results are averages of two, and sometimes three, experiments on the same fuel; and in many cases the metallic lead in two consecutive trials did not differ more than 2 grains, which corresponds to only 1-17th of a grain of pure carbon.

| | |
|---|---|
| 10 parts of the peat coke—this was picked surface peat—gave | 277 |
| 10 parts of peat coke, lower strata, | 250 |
| 10 parts of the pressed peat, | 137 |

The resin fuel, containing so much volatile matter, could not be tried in this way; and its calorific value could not be ascertained from the difficulty of arriving at any satisfactory result, except on a large scale.

The above numbers represent the relative quantities of heat which can be produced by the same quantities of each of the fuels; and in cases where quantity of heat alone is the consideration, these numbers will also represent their relative values.

But intensity of heat is often of more consequence than quantity; and intensity depends very much on the density of the fuel. Thus, charcoal can never produce so high a heat as coke; and, in this respect, the denser part coke and common coke are about equal. These comparisons are quite irrespective of any foreign matter being present which may be injurious to the quality of iron, where the fuel is used for reducing the metal from its ore, or for working iron by fire generally, or when it is used under iron boilers for generating steam.

To see how far it was probable or not that the peat coke contained matter likely to act injuriously in this respect, like some coke, portions were burnt in a variety of ways, when no sulphurous acid smell could, in any case, be perceived; sulphur, or metallic sulphurets, are the usual ingredients in common coke, to which their corrosive effects on iron boilers is to be attributed; and such coke, during burning, always gives very perceptible quantities of sulphurous acid gas.

As the nature and quantity of ash is sometimes of importance, I have also investigated these points with great care.

An average of two experiments, where 1000 grains of peat coke [made from the surface peat] were burnt till all carbonaceous matter was consumed, gave 5-100 for the quantity of ash of a light buff color.

| | |
|---|---|
| 100 grains of such ash cantain common salt, | 3. 5 |
| Silica—sand and silica combined, | 15. 0 |
| Sulphate of lime, | 22. 5 |
| Carbonate of lime, | 43.25 |
| Magnesia and carbonate of magnesia, | 15.00 |
| Alumina, | 0.75 |
| | 100.00 |

The ash contained no carbonate of potassa, and is remarkable for the large quantity of magnesia present.

From my trials I am of opinion,—1st, That the peat coke examined by me contains nothing which would, during the burning, be more injurious to iron than wood charcoal or the best coke—whether it be used to work iron, or under boilers for the generation of steam.

2d. That it is equal to the best coke, weight for weight; in heating power, a little inferior, weight for weight, to wood charcoal, where quantity of heat is the only consideration; but where bulk of stowage, and high intensity of heat are important considerations, it is superior to wood charcoal.

London, Jan. 18, 1839. Thomas Everitt.

The above analysis was made on turf from Lancashire; but, from other experiments, I find the turf from many of the bogs in Ireland exceeding it in purity, and containing a much smaller proportion of incombustible matter.

In considering the forgoing report and analysis, the great density of both the peat and peat coke, though produced from the lighter portion of the surface turf, is remarkable; the compressed peat being 30 per cent. denser than oak wood, and double that of the lighter woods, while the coke is double the density of charcoal, and on a par with coal coke.

I may here add, that this density, which is so valuable where intensity of heat is an object, may be still further increased, with little additional expense.

This being the first time that the results of the litharge test, as applied to turf coke, has been communicated in this country, the value of which Berthier, in his elaborate and admirable essay on combustible bodies, has fully established, I may be permitted to say, that its accuracy, and the small amount of practical error to which the process is liable, as shown by Mr. Everitt, gives it a high claim to our attention, although to persons not familiar with the nature of chemical tests, it may not be so self-evident. We here see that the extraordinary attraction which carbon has for oxygen, and the power which it thereby exercises of de-oxidizing metallic oxides, renders the litharge test the most suitable for determining the absolute purity and calorific powers of the various cokes, at least on a small scale. The carbon, under a high temperature, uniting with the oxygen in proportion to its calorific powers; while the lead, being thus deprived of that which is essential to its state of oxide, is precipitated in its pure metallic form, the relative weights so thrown down, representing the true combustible values of the several cokes,

It will be observed that Mr. Everitt, in stating the quantity and intensity of the heat given out by peat coke, adds, that these are irrespective of the presence of any foreign matter which may be injurious to the iron. Now, we know that many foreign substances do enter into the composition of coal and coke, and do exercise a very injurious influence over iron and steel in the furnace and forge. In this respect, the importance of the peat coke becomes apparent; iron is not only sooner brought by it to a welding heat, but it is found to work softer, and with less of that scaling which is so injurious, particularly in the operation of welding.

These facts I have proved both in the furnace where large boiler plates are heated, and in the operations of the forge where even the worst iron was improved in quality.

It is not an unimportant consideration that peat coke may thus be produced from that portion of the bog which has ever been rejected as a domestic fuel, when a denser kind is to be obtained. Again, that it is precisely that description of turf which most abounds in Ireland; and in most of the large bog districts has hitherto been regarded as an absolute incumbrance, alike unfit for fuel, and for conversion to agricultural purposes. This arises from its extreme porousness and levity—its being so far removed from that decomposition which is essential to the vegetative functions of all soils, and also to its susceptibility of the extremes of excessive moisture and excessive drought—overcharged in wet seasons, and amounting to a mere *caput mortuum* in dry ones.

The resin fuel, alluded to in the foregoing report, is an artificial coal formed by a union of this peat coke and bituminous matter up to the point of saturation. Of the uses and properties of this fuel, as well as of other advantages derivable from the application of peat, I shall, with your permission, on a future occasion submit to your consideration.

C. W. Williams.

MEMOIR OF LIEUTENANT COLONEL B. AYCRIGG ON THE SUBJECT OF THE LIGHT HOUSES AT BARFLEUR AND OSTEND.

(Continued from page 136.)

This splendor, although gratifying to the visiter, is of but little consequence in a work seen by few, except in its effects; but its practical importance is obvious, when we learn that a single lamp, with the consumption of one kilogramme of oil per hour, or one American gallon in four hours and ten minutes, will, from the mirrors, produce a constant light that can be seen at the distance of 5 French leagues, or 12 1-2 miles, and an intermitting light every half-minute that can be distinguished 12 leagues at sea, and even at times, when the direct rays are intercepted by the rotundity of the ocean, rendering the position of the light easily distinguishable, from a flash in the atmosphere, as the rays, concentrated on a small area, come in the direction of the observer.

Whether the distance of 12 leagues, at which it has been stated to the writer that the light can be seen, are French, statute, or nautical, he does not recollect; probably the latter, as it came from a seaman. These distances would be, respectively, 30, 36, and 41 1-2 statute miles; while, supposing the observer to be 140 feet above the surface, he could only see the direct rays at the distance of 33 1-2 miles, if we neglect refraction; but, allowing one-fifth of the average horizontal refraction for heavenly bodies, the rays might be seen the full distance of 12 nautical leagues, provided the light be strong enough.

As to the strength of the light, its intensity is much increased by being concentrated on a small portion of the horizon, in place of being scattered, and thereby weakened, in proportion to the square of the distance. According to the recollection of the writer, [although it was not timed by the watch,] the light is not seen for more than one-fourth of one of the periods, and the full light much less. If this be taken as the measure of the angle, we shall find the light sixteen times as strong as it would be without the lens, or as distinct at 41 1-2 miles as the naked lamp would be at 2 6-10 miles. But a lamp of this size could be seen much farther than 2 6-10 miles, and, consequently, without taking into consideration the greater intensity of the light near the axis, but making every allowance for the loss from the joints of the lenses, or a greater angle than the one supposed, there remains but little doubt on the mind of the writer that the twelve leagues mentioned were nautical, and the distance consequently 41 1-2 miles; and moreover, that under peculiar circumstances of the atmosphere, when the refraction is unusually great, the light would be visible still farther.

When seen by the writer, while passing at about twelve miles distance, it presented the appearance, not of a star or point of light, but of a brilliant red ball of fire, with a very sensible diameter.

The writer is not informed as to the first cost, but the current expense is a mere trifle. These considerations are, however, of less consequence than its utility; and, in this respect, it is generally considered by navigators to be the best light along the British channel, not even excepting the famous Eddystone, which is rather remarkable for its difficulty of construction and firmness in withstanding the shock of the waves than for the brightness of its light.

### *Details and measures.*

The column is 72 metres or 236 feet high from the base of the pedestal. The shaft is 27 feet diameter at the bottom and 18 feet at the top. A hollow cylinder is left in the centre, surrounded by 367 stone steps, commencing at the base and ending at the top. Through this cylinder the mate-

rials used in the construction were raised; and when the work was finished, a part of the cylinder was cut away to leave room for the keeper's sleeping apartment. Above this, is a thick arched stone floor, in which the shaft is placed, that supports the frames, and the lenses and mirrors. On the top of this shaft stands the lamp, while an extra lamp is kept in readiness, to be used in case of accident to the former, or derangement of its clock-work, to supply the oil. At about four feet below the lamp is the interior platform surrounding the shaft. No one is allowed to enter this place except the keeper and the engineer who has the supervision of the work, and in case of any derangement, the keeper is obliged to call on the engineer, and is not permitted even to touch the adjusting screws of the mirrors. At Ostend, however, the keeper, who was a much more intelligent man, attended to every thing.

Nearly the whole of the iron is of the same size. The frame of the interior cage for the mirrors, including the diagonal braces, the uprights, the supports of the interior platform, the lower ring on a level with the ring at the bottom of the lenses, the upper ring on a level with the upper ring of the lenses, the arched ribs, on the top of the cage, also the frame of the lenses surrounding the glass, the frame that carries the lenses, including the diagonals, the curved uprights, and the three rings are all made of iron 1 3-4 inches broad by 5 lines or 5-12 of an inch in thickness, and in all cases laid with its edge to the light. Both frames, the one revolving with the lenses, and that which remains stationary with the mirrors, are composed of eight similar parts, having all the rings divided into eight segments, and having eight diagonals and eight upright bars.

The upright bars of the inner cage pass within one inch of the frames of the lenses, and two opposite bars are connected on top by an electrical rib, reaching to the top of the window. The rings belonging to this frame coinciding in height with the rings above and below the lenses, and concentric with them, are constructed, in the same manner as the rings at the top and bottom of the uprights of the lens frame, having near the ends of each segment a flange at right angles to the flat side of the ring, so that when the ring is formed by bringing the ends of the segments together, there is an open mortice left for the end of the bars, the cheeks of the mortice receiving the end of the bar, when a screw-bolt, passing through the whole, fastens the bar to the ring, and at the same time holds the segments together. The ring at the top of the lenses not being connected with any bar, but merely screwed to the tops of the frames around the lenses, has the flanges immediately on the ends of the segments.

Attached to the inner cage are two rings of round iron, 7 1-6 of an inch in diameter, one on the inside and the other on the outside of the upright, so arranged as to receive the adjusting screws of the mirrors. These mirrors are of plate glass, set in brass backs and sides; they are one French foot [or 13 inches] long. They have each one adjusting screw in the middle, at the back, and one at each side, at 2 1-2 inches from the front. They are 4 3-4 inches beyond the range of the outside of the lenses. There are 4 between each bar, or 28 in a ring; the 4 on the land side being omitted, leaving a space below the lenses through which the keeper enters into the interior. They are as large as they can be made, so as to leave room for the adjusting screw at the sides; they vary in width according to the angle that they make with the vertical, and, by means of the adjusting screws passing into the wire, are regulated, so that the eye, placed in the position to be occupied by the lamp, sees the line of the horizon in the middle of the mirror, and consequently, in such a position that the light from the lamp will be reflected to the horizon.

The length of the mirrors being fixed, the vertical distance from one to the other must be such that no light is lost between them,

Above the lamp is placed a chimney to carry off the smoke, having the base of the cone out of range of the light from the lamp to the upper mirror.

The outer end of the 4 lower rings of mirrors all project the same distance, or 4 3-4 inches beyond the lenses. The first ring above the lenses is at the same distance beyond the lens, and the ends of the rest form a curve above, as will be seen from the accompanying plan and tabular statement of heights and distances. The wheels upon which the lens frame rolls are 6 in number, and 5 3-8 inches diameter. The friction-rollers below are 3-4 inch wide and 2 1-2 inches diameter, and are held in a ring with two open mortices, or tongue and jaws, that it can be taken off at pleasure. This ring is attached to the upper wheels.

Should it be thought a defect in point of firmness that the frames are divided into a great number of pieces, the necessity will be apparent, when the narrow passages through which they must be brought to the place required are taken into consideration.

The frame in which the lens is put by the manufacturer to hold the different pieces together, is made of the same sized iron as the two frames, or 1 3-4 inch by 4-12 of an inch; the exterior dimensions on the front are 34 inches high and 14 1-2 inches wide, and thence radiate to the centre, so as to fit close when placed side by side.

The plano-convex lens in the centre is 11 inches diameter.

There are 16 windows, 10 feet 6 inches high in the clear, composed of 5 panes of plate glass, the top and bottom being divided by a vertical strip in the centre. The width of the middle pane is 31 inches, and the frame is of iron 1 1-2 inch thick.

The following tabular statement of heights and distances corresponding, will give all the details of the measures, and from which a plan can easily be made to a working scale to supply the place of the accompanying miniature, which in some places is a little forced, in order to make the parts more distinct.

N. B. The first column gives the heights above or below the centre of the flame; those below having the negative sign. The second column gives the corresponding distances from the centre measured horizontally.

| | | |
|---|---|---|
| *Lamp.* | | |
| 0 | | centre of flame. |
| —3 | 1-2 | inner wick. |
| —3 | 11-12 | 2d wick. |
| —3 | 1 1-3 | 3d wick. |
| —3 | 1 3-4 | 4th or outer wick. |
| —6 1-2 | 4 | top of body of lamp. |
| —14 1-2 | 4 | bottom of body of lamp. |
| *Shaft.*—This should not be of wood above the platform. | | |
| —97 7-8 | 6 1-2 | re-entering angle at shoulder. |
| —97 7-8 | 12 | salient angle at shoulder. |
| —140 | 12 | at floor of masonry. |
| *Inside frame for mirrors.* | | |
| 66 1-2 | 0 | top of ribs joining in centre. |
| 19 1-12 | 31 7-8 | inside of flange at top. |
| 19 1-12 | 33 5-8 | outside of flange at top. |
| 17 1-3 | 33 5-8 | top of ring; thence the opposite bars are connected by a semi-eliptical ring rising to 66 1-2 |
| 17 | 33 5-8 | bottom of ring. |

| | | |
|---|---|---|
| 15 1-4 | 33 5-8 | bottom of flange. |
| —17 | 33 5-8 | top of ring. |
| —17 1-3 | 33 5-8 | bottom of ring. |
| —19 1-12 | 33 5-8 | bottom of flanges. N. B. This ring is not perfect, but merely segments, with a single flange on the lower side, that are laid between the upright bars, and bolted against them. |
| —48 | 33 5-8 | top of ring, and bottom of platform, not shown in the draught. Thence diagonals to the shaft. |
| *Revolving part.* | | |
| 19 1-2 | 35 5-12 | top of flange inside. |
| 19 1-12 | 37 1-6 | top of flange outside. |
| 17 1-3 | 37 1-6 | top of the upper ring. |
| 17 | 37 1-6 | bottom of the upper ring. |
| —17 | 37 1-6 | bottom of middle ring. |
| —17 1-3 | 37 1-6 | bottom of middle ring. |
| —19 1-12 | 37 1-6 | bottom of flange. |
| —24 1-12 | 43 | bar curving around the mirrors attached to the rings above and below. |
| —24 1-12 | 44 3-4 | |
| —59 1-2 | 44 3-4 | |
| —67 | 35 5-12 | top of lowest ring. |
| —67 | 37 1-6 | |
| —67 1-3 | 37 1-6 | bottom of lowest ring. |
| —69 1-12 | 37 1-6 | bottom of flanges. |
| —89 1-4 | 12 | top of flanges at cog-wheel. |
| —91 | 13 | outer corner of top of cogs connected with clock-work. |
| —92 1-2 | 13 | top of wheels [6 of them] upon which the frame revolves. |
| —97 7-8 | 13 | bottom of the 6 wheels, and top of shoulder. |
| —98 1-8 | 14 1-2 | outer upper angle of friction-rollers. |
| —98 7-8 | 14 1-2 | outer lower angle of friction-rollers. |
| *Lens.* | | |
| | 18 | centre of curved surfaces. N. B. The measures to |
| 0 | | the joints are the same, both above and below the centre. |
| 5 1-2 | 35 5-12 | 7th, at the re-entering angle. |
| 8 1-8 | 35 5-12 | 6th, N. B. From these points given, the front may be described from the centre at 18 inches from the centre of the lamp. These points are in the centre vertical section. The rim surrounding the lens is of iron 1 3-4 inch by 1-3 of an inch, and dimensions out to out, 14 1-2 × 34 inches. |
| 10 1-4 | 35 5-12 | 5th, |
| 12 1-8 | 35 5-12 | 4th, |
| 13 3-4 | 35 5-12 | 3d, |
| 15 1-4 | 35 5-12 | 2d, |
| 16 2-3 | 35 5-12 | 1st, |
| *Mirrors.* | | |
| 66 | 21 | outer end of the highest or 7th range. |
| 58 1-4 | 28 2-3 | 6th. |
| 49 1-2 | 33 | 5th. |
| 43 | 36 2-3 | outer end of the 4th range. |
| 36 | 39 1-2 | 3d. |
| 30 | 41 14 | 2d. |
| 24 | 42 | 1st above lenses. |
| —24 | 42 | 1st below lenses. |
| —28 5-6 | 42 | 2d. |
| —37 | 42 | 3d. |

| | | |
|---|---|---|
| *Upper floor.* | | |
| —59 1-2 | 46 | at edge near revolving bars. |
| —59 1-2 | 80 | at edge near window. |
| —60 1-2 | 80 | bottom. |
| *Window.* | | |
| 66 1-2 | 80 | top of glass, at edge of frame, in middle. |
| 66 1-2 | 81 2-3 | top of glass, at edge of glass. |
| 66 1-2 | 38 1-3 | at glass in angle. The frame is 1 1-2 inch thick. |
| 19 | 83 1-3 | bottom of upper pane divided in middle. |
| 17 1-2 | 83 1-3 | top of middle pane full size, [31 inches.] |
| —17 1-2 | 83 1-3 | bottom of middle pane. |
| —19 | 83 1-3 | top of lower pane divided. |
| —59 1-2 | 83 1-3 | bottom of lower pane. |

*Light at Ostend, on the coast of Belgium.*

From the minute description of the complex lantern at Barfleur, the more simple light at Ostend will be readily made inteligible.

This light ranks No. 3, while that at Barfleur is No. 4, or the highest grade in use, according to the statement of the keeper at Ostend. The lamp of this has but three wicks; that has four. The height of this column is not over one-half of the other, nor is the lantern more than two-thirds the diameter. There are no revolving lenses; but the object in this case being to produce a constant light around the whole circumference of the horizon on the sea side, the mirrors above and below, and the refracting glasses between them, are all attached in a simple manner to an upright cage, or frame of iron, supported immediately on the floor. These, as usual, are omitted on the land side, and in this place the refracting glasses are also omitted, as they do not revolve as those at Barfleur. A reflector near the lamp throws this light towards the sea.

These refracting glasses are not lenses, but straight prisms, having the back plane and front surface curved towards the horizontal plane from the lamp. As these prisms lie horizontally one above the other, held in their places by the surrounding frame, the vertical cross-section, taken at any place across the glass, would present the same figure as the vertical cross section in the centre of the Barfleur lens.

This latter concentrates the light that falls upon it to a point, or small area along the horizon; while the former, not being a lens, but a compound prism, acts only in a vertical direction, and therefore deflects the light to a horizontal plane or narrow zone.

Every thing about this light house is on a smaller scale, but sufficient for the purpose, since lights are frequently along this coast; and one more powerful would be of no superior advantage in clear weather, since this is now sufficiently strong for its height above the surface.

The above will give a full knowledge of the details of the lenticular system, and it is therefore considered unnecessary to dilate further on the subject. Respectfully submitted:

B. Aycrigg, *Civil Engineer.*

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Central Railroad.—In Thursday's *Daily* in alluding to the scite of the depot we remarked, that "we recollect that *five years* ago this was almost a barren spot," &c. If we had reflected one moment, we would have said *not three years ago*, &c., for we well recollect that the first spade was not struck in November, 1836, and in December of that year we were gratified with the commencement then made near the city. The rapid progress since made, speaks volumes for the energy of the President and Directors. [*Georgian.*]

## THE READING RAILROAD: ITS ADVANTAGES FOR THE CHEAP TRANSPORTATION OF COAL, AS COMPARED WITH THE SCHUYLKILL NAVIGATION AND LEHIGH CANAL. BY W. EDWARDS.

(Continued from page 159.)

### READING RAILROAD.—NO. V.

In No. III. it was shown, that a boat costing $550 is capable of carrying on the Schuylkill navigation, from 55 to 57 tons of coal each trip, and would, were there no detentions other than the passing of the locks, be able to make twenty trips in the season of eight months, the time the canals are usually open; but owing to the occasional overflowings of the tow-paths by spring and fall freshets, and to the droughts of summer, the full average number of trips is seventeen, and the average load 54 14-20 tons, making in all an annual tonnage for each boat of 930 tons. Average time of each trip up and down, two weeks.

As a great increase in the number of trips has been asserted as possible, and a consequent diminution of the per ton cost, it will be well to examine how far it is practicable to increase them.

Each horse drawing the coal boats, is capable of working twelve hours on an average daily. In the pools, which are thirty-four in number, and in length 50 miles, his speed with a loaded boat is three miles per hour; in the canals, twenty-seven in number, and in length 58 miles, his speed is reduced [owing to the increased resistance from the water being confined by the canal banks] to two miles per hour, exclusive of delays in passing the locks and waiting the regular turn to pass. The delay at the locks is greatest with a large trade on the canal, and is estimated by persons engaged in boating as equal on an average to two minutes for each lock, besides the time required to pass the lock, which averages six minutes, being in all for each lock eight minutes.* Returning with empty boat, the speed in the pools is increased to 4 miles per hour, and in the canals to 3 miles per hour. The time required to pass from Fairmount to the coal wharves, to wait there till the tide suits, to unload and return to Fairmount, averages twelve hours, or one day. Delay at the coal landings at Pottsville in receiving cargo, &c., twelve hours, or one day. Total time for each trip, as follows:

| | | |
|---|---|---|
| Time at Pottsville receiving cargo, &c., - | 12 hours, or | 1 day. |
| Time descending through pools, - - | 17 " | 1 1-2 " |
| Time descending through canals, - - | 29 " | 9 1-2 " |
| Time ascending through canals, - - | 19 " | 1 1-2 " |
| Time ascending through pools, - - | 13 " | 1 " |
| Time in passing 234 locks, 8 minutes at each, | 30 " | 2 1-2 " |
| Time at Philadelphia unloading, &c., - | 12 " | 1 " |
| Total, | 132 hours or | 11 days. |

It will thus be seen that at least eleven days are required to perform a trip, without accident to boat or detention from too much or too little water in the pools, and that it is not possible to accomplish it in less time, unless by increasing the number of horses and hands to manage the boat, and by running a greater number of hours per day, which would add to the cost fully equal to the increased speed, and even exceed it. This has been proved by experience.

The entire distance from Pottsville to the coal wharves on the Schuyl-

* The Lehigh navigation company, in the last report, say, "the total interruption or detention at each lock, may average six minutes, or 12 minutes going both ways which would be 10 3-4 hours for 44 locks."

kill, and returning to Pottsville per the Schuylkill navigation, is 216 miles, and is performed in six and a half days, [exclusive of one day's delay at Pottsville in loading, &c., one day's delay at Philadelphia unloading, &c., and two and a half day's detention in passing 234 locks],—say six days and a half of twelve hours each, or seventy-eight hours, which gives an average speed for each horse of two and three quarter miles per hour, and the number of trips being seventeen in the season, gives a total distance travelled by each horse of 3,672 miles. If the boatmen attempt to push the horse beyond this speed, the animal is over worked and injured; besides, the men engaged in navigating the boat are not able to work more than twelve hours daily.

The speed for the train engines to be used in drawing the coal cars on the Reading railway, will be about 8 miles per hour, or about three times that of the horses on the canal. The distance from Pottsville to the coal wharves of the company on the Delaware, being 94 miles, the time required to perform it will be one night of twelve hours, and the engine will remain at Philadelphia during the whole day for examination and repairs [when necessary], and return with the empty cars during the next night of twelve hours to Pottsville; the cars being in the mean time or during the day, unloaded directly into the vessels from the company's wharves on the Delaware. During the next day the engine will remain at Pottsville for examination and repairs, and the cars will be loaded during the day, and be ready to return to Philadelphia the same evening. By this arrangement, it will be perceived that the cars are either at Pottsville during the day or twelve hours being loaded; or at Philadelphia during the day or twelve hours being unloaded; and also that the engines are during the whole of each day at either end for examination and repairs [when necessary.]

Thus one half the number of cars will carry the same amount of tonnage that could be done by loading them during the day time, and bringing them down the next day, and unloading them the day after, and taking them back on the fourth day, or in all for each trip four days; whereas by the above arrangement, two days and nights will be sufficient for each trip. It is true, there will be an additional expense for wages, &c., running at night; but this will be more than counterbalanced by each engine and car performing a trip up and down in two days and nights, instead of four days.

To bring from Pottsville to this City, 930,000 tons of coal, by the Schuylkill navigation, would require (each boat being capable of bringing 930 tons in the season) one thousand boats, one thousand captains, one thousand men, one thousand boys, and one thousand horses. The total working capital would be

| | | |
|---|---|---|
| First cost of | 1000 boats at $550 each, - - | $559,000 |
| " " | 1000 boats' furniture, at $25 each, - | 25,000 |
| " " | 1000 horses, at $80 each, - - | 80,000 |
| Six hundred and fifty-five thousand dollars | | $655 000 |

Total cost of running each boat per season, as shown in No. III., is $1,082,22 which for 1000 boats is $1,082,220

One million and eighty-two thousand, two hundred and twenty dollars.

To bring from Pottsville to this city, 930 000 tons of coal by the Reading railroad, would require 31 engines [of Wm. Norris' class B. of engines of equal power, each engine drawing in the year, 30,000 tons,] 31 engineers, 31 firemen, and 155 men to attend the trains—5 men to each train.

And should 4 ton cars be adopted by the company (each car performing 125 trips annually, would bring 500 tons) it would require 1860 cars.

The total working capital would be

| | |
|---|---|
| The first cost of 31 locomotive engines, at $8000 each, | $248,000 |
| First cost of 1860 cars, at $258 each, - - | 465,000 |
| Seven hundred and thirteen thousand dollars. | $713,000 |
| Total cost of running each engine *per annum*, is $5000, which for 31 engines is - - - | $155,000 |
| Total cost of running each *per annum*, is $105 50, which for 1860 cars is - - - - | 196,230 |
| | $351,230 |
| Total cost of freighting, per Schuylkill navigation, 930,000 tons is $1,082,220, or per ton - - - | $1 16 1-2 |
| Total cost of freighting per Reading railroad, 930,000 tons is $351,230, or per ton, - - | 0 37 3-4 |

Thus it appears, that should the company use coal cars capable of carrying 4 tons each, and the engines be able to make 150 trips annually, the cost of freighting will be reduced from 51 3-4 cents, as estimated in No. III., to 37 1-2 cents per ton.

### READING RAILROAD NO. VI.

By referring to No. III., it will be seen that the expenses on each ton of coal, per the Schuylkill navigation, from the landings at Pottsville to the hold of the vessel in the Schuylkill, are $3 23 1-2 cents.

The Lehigh coal and navigation company are at present able to bring their coal from their mines and discharge it into the vessel from their landing at Bristol for about 65 1-2 cents per ton less than the coal dealers on the Schuylkill, and have consequently driven out of the market almost all the dealers in white ash coal. Those engaged in mining and bringing to market red ash coal, have been enabled to continue their business, mainly from the fact, that red ash coal is peculiar to the Schuylkill coal region, and commands in the eastern markets a price beyond that of the white ash coal. When, therefore, the Lehigh company shall succeed in obtaining the law for an outlet lock at Black's Eddy [as sooner or later they may,] they will be enabled to transport coal to New York from 40 to 50 cents per ton less than they do at present, or from $1 05 to $1 151-2 per ton less than by the Schuylkill navigation.

If to the costs per Schuylkill canal, $3 23 1-2 we add $1 25 freight from this city to New York, it gives a total cost of $4 58 1-2 per ton. By the Lehigh Canal the total expenses from their mines to New York is about $3 93 per ton : but with an outlet lock at Black's Eddy, this would be reduced say 50 cents, or to $3 43 per ton.

The Lehigh company have, therefore, a present advantage over the Schuylkill navigation company of 65 1-2 cents per ton, with a further prospective one, of from 40 to 50 cents, or in all from $1 05 1-2 to $1 15 1-2 per ton.

The whole toll on the Schuylkill navigation being but 92 cents per ton, it is evident that some other and cheaper means of conveying our anthracite to market, must be resorted to, in order to prevent the great evil of a diversion of the coal trade from our city. In this view, the Reading railroad becomes a matter of just pride to every citizen of Pennsylvania interested in her growing prosperity, and to the citizens of Philadelphia, especially, it is a matter of deep interest. Who has not looked with pride upon

the hundreds of vessels in our river, receiving their cargoes of coal? And who would not arrest the hand that would attempt to divert this trade from our city? The deep interest felt in this community was recently shown by the numerous and respectably signed petitions that filled the desks of our representatives at Harrisburg, protesting in strong language against the passing of any law allowing the diversions of the coal trade from Philadelphia.

*The inability of the Schuylkill navigation company to retain the trade is manifest;* and the vast importance of that trade, and the large increase of it to be looked for, invest with peculiar interest the examinations that have been made, in regard to the ability of the Reading railroad to transport coal cheaper than either Lehigh canal or Schuylkill navigation companies.

That a cheaper means of conveyance than the present is required to continue the coal trade at Philadelphia, is no longer a question among practical men, or those who have examined the subject.

Such a means the Reading railroad presents to them. Though some may affect to doubt its entire success, yet the question of railroad transportation is now so well understood in Europe and in this country, that it is no longer a matter of theory. The Reading railroad, with its unparalleled favorable grades, has the power of transporting at the minimum cost of railroad transportation; and as the trade will be uniform, the engines having full and constant work, while the fuel will be obtained at the lowest price from the mines, it follows that all that can be accomplished by locomotive power may be safely looked for from the engines on this road; and the estimate of the cost of transportation, made in No. III., may be referred to as matters not of theory, but as results drawn from experience on other roads, both here and in Europe.

| | |
|---|---|
| It was there shown that the cost for motive power on the Reading railroad, is per ton, - - - - | $0 23 1-2 |
| For use of cars, - - - - - - | 0 28 1-4 |
| For increased care in screening coal at mines, per ton, | 0 12 |
| For discharging coal from cars into vessels, &c., - | 0 15 |
| | 0 78 3-4 |
| To which add for toll, 1-2 cent per ton per mile, 94 miles, | 0 47 |
| And for freight to New York, - - - | 1 25 |
| | $2 50 3-4 |

TOTAL EXPENSES FROM THE MINES TO NEW YORK PER READING RAILROAD, TWO DOLLARS AND FIFTY CENTS AND THREE QUARTERS.

The Reading railway, therefore, possesses the power of transporting coal to New York 92 1-4 cents per ton less than the Lehigh company, even with the outlet lock at Black's Eddy, allowing the railroad 1-2 cent per ton per mile for toll. But in a close competition, the Reading railroad company could omit all charge for toll, inasmuch as they have a business, the profit on which, from passengers, merchandize, and the United States Mail, as estimated by Messrs. Moncure and Wirt Robinson, the engineers of the road, amounts to $437,655 *per annum*, while the total expenses of the road are estimated at $153,200, leaving $284,455; whereof $100,000 is required to pay interest on loans, $2,000,000, at 5 per cent., and the balance $184,445 divided amongst the stockholders, gives on the capital of $2,000,000, an annual dividend of 9 1-4 per cent.

The Reading railroad company could therefore come into the market

prepared to carry coal *without any road charge*, and the respective abilities of the two companies would then stand thus :

| | |
|---|---|
| Cost per ton from the Lehigh mines to New York, per Lehigh railroad and canal, State canal, Black's Eddy outlet, and Delaware and Raritan canal, to New Brunswick, and thence to New York, - - - - | $ 3 43 |
| Cost per ton from Pottsville to New York, per Reading railroad to the Delaware, thence by sea or by the Delaware and Raritan canal, &c., to New York. - - | 2 03 3-4 |
| | $ 1 39 1-4 |

Difference in favor of Reading railway [excluding toll on coal,] one dollar thirty-nine cents and a quarter,

As, however, the Lehigh company's valuable coal lands adjoin the Little Schuylkill railroad at Tamaqua, about 20 miles above Port Clinton [and at Port Clinton the Little Schuylkill railroad will be connected with the Reading railroad] and the distance from Port Clinton to Philadelphia is 79 miles, their coal will be within 5 miles as near to this city as that from the Pottsville region. It will therefore be manifestly their interest as coal owners, to open their mines at Tamaqua, whence by the above route their coal would descend 20 miles over the Little Schuylkill railroad to Port Clinton, and thence 79 miles over the Reading railroad [in all 99 miles] to Philadelphia.

Should the Lehigh Company succeed in selling their canal to the State which they have endeavored to do, this would then be to them a most unobjectionable means of transporting their coal to a market.

(To be continued.)

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THE CENTRAL RAILROAD.—This great work is progressing rapidly. The cars now run eighty miles and five miles farther are completed. Already is the attention of the people in this section turning towards it, as the best and most expeditious mode of getting their crop of the present year to market. It must be borne in mind that we are sixty miles from the present terminus.

Whatever prejudices may have existed against this enterprise are rapidly disappearing: and as it approaches to our immediate neighborhood, its benefits are not only theoretically but practically exhibited. The fact is, the next legislature must be liberal in the course pursued to the central railroad, without doubt the most beneficial, as well as extensive undertaking of the kind now in progress in Georgia.

We anticipate with delight the time when we shall be able to visit Savannah, without the long and tedious journey we have so often undergone. Let us speak a word of advice to old Chatham, which, if not the land of our birth, was for many years our happy home, endeared to us by a thousand remeniscences of childhood, of joys departed, which in this world can be felt no more, and of treasured friends now separated never to be united again. But to the point, you have five members allowed you to the next legislature, we are happy to see our friends, whether Union or State rights, but a nature is preferable at present, as the Union party have the power, we cannot expect them to allow the State rights party the majority, but you can very well give us two, which would be an instance of generosity seldom met with, and therefore the more creditable. It is the interest of Chatham to pursue this course, send men, however divided in politics, who will unite for the interest of the railroad, and it will be a great step taken in accomplishing your favorite object.—*Sandersville Advocate.*

HORTICULTURE.—The Horticultural Society of the valley of the Hudson, held a meeting recently, at the saloon in Niblo's garden. The display of plums, peaches, nectarines, mellons, filberts, grapes, etc., were the most choice and inviting we have ever seen. The exhibit of flowers, particularly of Dahlias, truly gorgeous, and the show of vegetables fine. Among the latter a squash, 184 lbs., from Fishkill.

The contributors were not numerous. New York and Brooklyn, Messrs. Prime, Hogg, Perry, and others; Mr. Downing and others of Newburgh; Mesers. Holbrook, Kneeland and others, of Hyde Park; Mrs. Stephen Van Rensselaer, Buel, Denison, and others of Albany; A. P. Heartt of Troy, etc., etc.

The address, by *William Emmerson, Esq.*, a highly finished performance.

The subject of this paragraph does not fitly belong to our Magazine, or we would enter more in detail on this truly facinating science, that may be said, assists nature to improve her own productions. We cannot, however pass the gardners' *Coat of Arms*, a pretty fancy, quite out of the common order, partaking so much of mechanical nicety, that we give the following from the Commercial Advertiser. A drawing of the *coat* of *arms* ought to be taken and fully placed before the readers of our rural publications; but to our extract.

"The gentleman whose contributions are the most extensive and various, is Alexander Walsh, Esq., of Lansingburgh. And to his taste the society is indebted for a very appropriate and beautiful ornament, at the head of the saloon. It is what Mr. W. has fitly named the horticulturist's coat of arms, forming a pyramid, twenty-four feet high, constructed entirely of the various instruments of horticulture. A thermometer, handsomely decorated, is placed in the centre with the motto, "SCIENCE DIRECTS OUR MOVEMENTS." The spade, rake, hoe, &c., &c., covered with a wreath of evergreens, and decorated with a superb variety of dahlias, rare exotics, and native flowers, form the frame work of this fanciful device. From the most prominent parts of the structure are suspended filberts, teazle, madder-root, woad, sumac, perennial flax, &c., all produced by Mr. Walsh, emblematic of the aid horticulture affords to manufactures. The silk business is fully represented by the eggs, reeled silk, and a tasteful display of cocoons and wreaths of the silk moth. Near the centre of the structure, the grape, and that which maketh the heart glad, corn, oil, and wine, are justly represented.

The pedestal, some thirty feet long, is loaded with some fifteen or twenty varieties of plums, also apples, pears, filberts, a profusion of choice and rare vegetables, and we may here also mention, a diminutive bee hive, and a sun-dial.

On the right, a little raised from the pedestal, are placed a variety of rural engravings. Copies of the New York, New England, Michigan, and Genesee Farmer, the Cultivator, and other publications, fully to complete this gardener's budget, have likewise been placed upon the table—Mr. Walsh's motto being—

"*Son utile ainda que bricondo.*"
"I am useful even when sportive."

Table of the mean temperature of each of the months for the years of 1833, 1834, 1835, 1836, 1837, and 1838. Also the day the thermometer was at the *extreme* lowest and highest; and the number of days that was clear, cloudy, rainy, white frost, foggy morning, snow, hail, or sleet, in each month. From the meteorological record kept at Avoylle Ferry, on Red river, Louisiana. Lat. 31° 10″ north, lon. 91° 59″ west, nearly. By P. G. Voorhies.

(Concluded from page 160.)

| Date. | | Mean temp. of months. Morn | Noon | Night | of the m'nth | Thermometer, the extreme in each month. Day. | low'st | Date. | high't | Number of days in each month that was either Clear | Cl'dy | Rainy | white frost. | foggy morn. | Snow | hail or sleet |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June | 1833 | 73 | 85 | 79 | 79 | June 25th | 64 | June 30th | 90 | 25 | 5 | 5 | | | | |
| | 1834 | 72 | 87 | 81 | 80 | " 12 | 68 | " 30 | 90 | 21 | 9 | 6 | | | | |
| | 1835 | 73 | 84 | 79 | 79 | " 3 | 70 | " 29 | 88 | 19 | 11 | 11 | | | | |
| | 1836 | 71 | 85 | 79 | 78 | " 5 | 62 | " 9 | 90 | 19 | 11 | 5 | | | | |
| | 1837 | 72 | 84 | 83 | 79 | " 22 | 59 | " 2 | 91 | 21 | 9 | 6 | | | | |
| | 1838 | 76 | 86 | 79 | 80 | " 4 | 72 | " 25 | 94 | 30 | | | | | | |
| July | 1833 | 73 | 88 | 80 | 80 | July 5th | 67 | July 29th | 93 | 28 | 3 | 3 | | | | |
| | 1834 | 73 | 87 | 80 | 80 | " 14 | 70 | " 4 | 91 | 20 | 11 | 7 | | | | |
| | 1835 | 72 | 82 | 77 | 77 | " 3 | 61 | " 29 | 89 | 15 | 16 | 14 | | | | |
| | 1836 | 75 | 87 | 81 | 81 | " 21 | 64 | " 23 | 93 | 20 | 11 | 5 | | 1 | | |
| | 1837 | 74 | 87 | 81 | 81 | " 1 | 73 | " 15 | 89 | 25 | 6 | 6 | | 1 | | |
| | 1838 | 75 | 86 | 79 | 80 | " 4 | 72 | " 1 | 90 | 19 | 12 | 12 | | | | |
| August | 1833 | 73 | 88 | 82 | 81 | August 18th | 67 | August 5th | 92 | 22 | 9 | 3 | | | | |
| | 1834 | 75 | 86 | 81 | 81 | " 31 | 67 | " 20 | 92 | 18 | 13 | 8 | | | | |
| | 1835 | 73 | 83 | 79 | 79 | " 27 | 67 | " 20 | 89 | 14 | 17 | 13 | | | | |
| | 1836 | 74 | 86 | 79 | 80 | " 22 | 66 | " 8 | 90 | 19 | 12 | 10 | | | | |
| | 1837 | 73 | 85 | 82 | 80 | " 15 | 68 | " 8 | 90 | 25 | 6 | 3 | | | | |
| | 1838 | 72 | 86 | 80 | 80 | " 24 | 68 | " 14 | 90 | 23 | 8 | 7 | | | | |
| Septemb'r | 1833 | 71 | 84 | 79 | 78 | Septemb'r 23d | 58 | Septemb'r 1st | 88 | 18 | 12 | 6 | | | | |
| | 1834 | 66 | 77 | 73 | 72 | " 8 | 54 | " 2 | 88 | 17 | 13 | 13 | | | | |
| | 1835 | 66 | 78 | 74 | 72 | " 24 | 60 | " 6 | 86 | 24 | 6 | 2 | | | | |
| | 1836 | 71 | 83 | 76 | 76 | " 30 | 62 | " 3 | 86 | 12 | 18 | 15 | | | | |
| | 1837 | 70 | 80 | 74 | 74 | " 19 | 56 | " 9 | 88 | 14 | 16 | 10 | | | | |
| | 1838 | 64 | 79 | 76 | 73 | " 24 | 41 | " 8 | 87 | 26 | 4 | 3 | | 1 | | |
| October | 1833 | 53 | 69 | 63 | 62 | October 22d | 33 | October 16th | 85 | 24 | 7 | 5 | | | | |
| | 1834 | 60 | 75 | 71 | 69 | " 20 | 37 | " 30 | 88 | 18 | 13 | 5 | 2 | | | |
| | 1835 | 59 | 73 | 66 | 66 | " 9 | 46 | " 2 | 82 | 21 | 10 | 5 | | 2 | | |
| | 1836 | 54 | 67 | 62 | 61 | " 21 | 41 | " 1 | 80 | 20 | 11 | 4 | 2 | 1 | | |
| | 1837 | 61 | 70 | 69 | 67 | " 25 | 34 | " 1 | 82 | 17 | 14 | 4 | 1 | 3 | | |
| | 1838 | 60 | 70 | 66 | 66 | " 30 | 40 | " 15 | 86 | 25 | 6 | 6 | | 1 | | |
| Novemb'r | 1833 | 46 | 65 | 59 | 57 | Novemb'r 26th | 25 | Novemb'r 11th | 78 | 22 | 8 | 5 | 7 | | | |
| | 1834 | 52 | 67 | 63 | 61 | " 27 | 28 | " 5 | 82 | 24 | 6 | 5 | 3 | 1 | | |
| | 1835 | 51 | 62 | 58 | 57 | " 29 | 32 | " 19 | 79 | 13 | 17 | 10 | 2 | 2 | | |
| | 1836 | 39 | 56 | 53 | 49 | " 30 | 28 | " 2 | 64 | 28 | 2 | 1 | 7 | 1 | | |
| | 1837 | 54 | 67 | 66 | 62 | " 23 | 31 | " 11 | 84 | 20 | 10 | 2 | 4 | 3 | | |
| | 1838 | 44 | 57 | 53 | 51 | " 19 | 28 | " 6 | 74 | 16 | 14 | 6 | 6 | 1 | | |
| Decemb'r | 1833 | 46 | 58 | 55 | 53 | Decemb'r 26th | 29 | Decemb'r 1 | 68 | 14 | 17 | 5 | 6 | 3 | | |
| | 1834 | 45 | 60 | 56 | 54 | " 27 | 31 | " 1 | 75 | 15 | 16 | 8 | 7 | 1 | | 1 |
| | 1835 | 46 | 62 | 58 | 55 | " 23 | 22 | " 19 | 74 | 17 | 14 | 5 | 7 | 1 | | |
| | 1836 | 42 | 55 | 51 | 49 | " 21 | 19 | " 24 | 76 | 19 | 12 | 4 | 9 | 1 | | 1 |
| | 1837 | 46 | 55 | 52 | 51 | " 11 | 29 | " 16 | 74 | 18 | 13 | 4 | 6 | | | |
| | 1838 | 40 | 51 | 47 | 46 | " 24 | 21 | " 2 | 63 | 14 | 17 | 5 | 14 | 1 | | |

Harlem Railroad.—The receipts on this road for the month ending yesterday, are as follows, viz:

Sept. 1st to Oct. 1st, 1839, $12,881 48

Sept. 1st to Oct 1st, 1838, 8,770 80

showing an increase the last month over the corresponding month of last year of $4110 68, equal to 47 per cent.

The number of pssengers conveyed on the road were one hundred and twenty-eight thousand three hundred and twenty-seven, including the passage both ways—being at the rate of one million five hundred and thirty-nine thousand and twenty-four passengers per annum.

The number of passengers taken on the road, who paid six-pence only, were seventy-six thousand one hundred and twenty-nine.

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

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## RIGHT OF WAY FOR RAILROADS, AND LOCATIONS THROUGH VILLAGES. BY W. R. CASEY, CIVIL ENGINEER.

The "right of way," though not exclusively an engineering consideration, begins to assume so very imposing an appearance in detailed statements of the cost of railways in all parts of the United States, that the following remarks can scarcely be out of place in a Journal open to all discussions, which may tend to advance the cause of internal improvements. A statement of the amount per mile paid by a great number, perhaps a majority, of American railroads would scarcely be believed by the uninitiated, and still more improbable would appear a fair unvarnished account of the system, or rather want of system, which has characterized the manner in which the negotiations for the land have been conducted.

The cost of right of way on the following roads, will be the best illustration of the importance of this subject. These roads are all in this State, or its immediate neighborhood, and very many of the readers of this Journal are able to furnish lists, much more formidable, both as to number of roads as well as cost per mile for right of way.

| | |
|---|---|
| Long Island railroad, for right of way per mile, | $7000 |
| New Haven and Hartford, | 7000 |
| Utica and Schenectady, | 4000 |
| Syracuse and Auburn, | 3000 |
| Hudson and Berkshire, | 2000 |
| Great Western, | 1700 |
| Camden and Amboy, | 2600 |
| New York and Erie (Eastern terminus,) | 2000 |
| " " (Western " ) | 1000 |

The right of way on the two first roads on the list, cost as much as (excluding engineering and contingences,) *the graduation, masonry, bridging and superstructure of the Champlain and St. Lawrence railroad* in Low-

er Canada, all of which was done *by the day*, under the immediate direction of the writer of this paper.

In some few instances, as in the case of the Utica and Schenectady railroad the location is so fixed by circumstances that the route is necessarily known to all, but, generally speaking, it will be found that the amount paid, will be great or small, according to the progress which has been made towards a final location at the time of the purchase—thus, it is supposed that the land on the line of the New Haven and Hartford railroad could have been obtained for little or nothing, if the right of way had been secured *before* anything was known of the engineering claims of either route. Again, on the route of the Great Western railroad in Massachusetts it would probably have been as easy to secure a "bonus" for the benefits actually conferred by the road as to pay for the injury inflicted on the inhabitants of that isolated country by cutting up their wilderness with a railway, and connecting them with the western country and two great atlantic cities.

The price paid has also been influenced by the benefits conferred.—The Great Western railroad just referred to, is a case in point. On the New York and Erie railroad, not only the right of way, but donations of land would have been readily granted, *until* the State ordered 10 miles at each terminus to be *immediately* put under contract, when 2000 and 1000 dollars per mile at the eastern and western ends respectively was paid. On the Long Island railroad a farmer between the race course and Jamaica, whilst urging his claim for heavy damages, was negotiating and actually effected the sale of his farm, at an advance of $3000 on its previous value, *because* it was crossed by the railroad. The proprietor of a farm on the Central railroad in Michigan, demanded 13000 dollars for damages, though the roads were previously such as to require half a day to reach Detroit, a distance of 10 miles, whilst by the railroad the property was brought within three quarters of an hour of that city and proportionally increased in value. Of this sum, he received $5000 nearly two years since, and if he has not received the remainder, has certainly very strong claims on the ground that the damages should be in proportion to the benefits conferred by the improvement. The enlargement of the Erie canal will undoubtedly afford some examples worthy of that sublime [or ridiculous ?] project, though damages have as yet found no place in the estimate. It is but fair to state that as interest was excluded, though it will amount to at least ten millions of dollars, it could not be expected that the paltry sum of 3 or 4 millions for damages should be entitled to the honor of a place in the commissioners and engineer's estimate of 1839. The Railroad Journal [August,] page 80, gives an example which shows that, in the interior of Tennessee, the same system of extortion is pursued. The line was located before the releases were obtained and the land derives its value from its proximity to the road, *ergo*—heavy damages to be *paid* instead of free right of way, donations of land for buildings, and liberal subscriptions to the stock *being received*. Exam-

ples abound on almost every road in the Union, but enough have already been quoted.

On the Troy and Ballston, and Cattskill and Canajoharie railroads, the land was obtained for a mere trifle, because the entire arrangement was left to *one* competent agent, who obtained releases *on rival* lines—and in this lies the whole secret. Nothing is more common than a general promise of the right of way before the surveys commence, but at the very first glimpse of the stakes, the farmer swears that the route is the very one to which he cannot agree, and that the engineer has devoted his entire skill, science and industry, to do him (the farmer) the greatest possible injury, and if, as sometimes occurs, he should find out that this line has some advantages, he is suddenly beset by a new cause of anxiety—on the one hand he fears to drive the company into another location by demanding too much, on the other side he dreads the very idea of underrating his reasonable claim on them for the privilege of doubling or quadrupling the value of his property by their capital and enterprise. Whilst under the influence of these amiable and generous feelings something may perhaps be done with him—but as soon as he *knows* the route there is an end of all negotiation, and it only remains for the company to submit with resignation to his sheers like their brethren in simplicity, the sheep.

The treating for the right of way has been conducted in various manners, but advantageously only, when entrusted to a single agent. It is well known that the bad locations which, with a few honorable exceptions, characterize the railways of the United States, are in no small degree owing to the want of time to make the requisite surveys, and to institute careful comparisons between rival lines; it is also evident that the information acquired by the engineer in his preliminary surveys is necessary to point out the general direction of the best lines, hence the proper course to be pursued is plainly defined. Some competent person should be authorized by the directors to accompany the engineers, and as their operations show the lines between which the choice lies, he should make himself intimately acquainted with the proprietors, their views and wishes—the grand object being to secure the releases on rival lines *before* the results of the surveys can be known by any, except the principal engineers, and often only very partially by them.

It will be readily observed that the only chance of success is based on the perfect understanding which must exist between this agent and the engineer, and equally indispensible on the part of the former are tact, activity, intelligence—and urbanity of manners. The immense sums paid in various parts of the Union for right of way, are the best arguments to show the propriety of selecting a person in every way qualified, and the absolute necessity of procuring releases in the early stages of the surveys, has been sufficiently alluded to. Where this system has been closely adhered to, as in the cases of the Cattskill and Canajoharie, and Troy and Ballston railroads, it has been attended with signal success, and invariably will be, where-

ever the inhabitants desire to have the railway in their neighborhood though without touching their property, which is the case in nine-tenths of the routes in the country. But the same principle is equally applicable where all are opposed to the railroad "in toto," as with the French farmers in Lower Canada. There the whole arrangement was placed in the hands of a French gentleman of high standing totally unconnected with the railroad, and whilst the farmers received a very liberal compensation, the company were enabled to commence operations without loss of time. Circumstances, however, prevented the possibility of purchasing the ground at the termini for depots, etc, until *after* the opening of the road, and, as the property derived its entire value from the operations of the company the *damages* were in proportion.

The commissioners of the New York water works, state that they have paid $600 per acre, though in many cases the land on steep hill sides was previously of no value. It would, perhaps, be impossible to find another instance of similar prodigality, and the utter want of all the qualifications which have been already enumerated as indispensable in the agent entrusted with this much neglected business. In England 100*l.* per acre is considered a full price for the *purchase* of the land, but here that sum has been paid for the occupation of the land for two years, and in many cases, as the commissioners themselves say, land previously useless is now cultivated. The present line was located in '33, and had the land been then conditionally secured on the rival lines, and before it was known which line would be preferred, it is not unreasonable to suppose that the damages would not have exceeded one-tenth of their present amount. When, however, private companies have been thus neglectful of their *own* interests, it can hardly be expected that men, political agents, should take much trouble to save the money of the public; and indeed, every thing goes to show, that it is a matter of choice with the directors, whether by early and efficient arrangements they shall pay a moderate sum for the right of way, or by procrastination and indecision, pay ten times the value of the land, and thus directly sanction and encourage that wretched spirit of extortion and extravagance which, unless soon checked, bids fair to become as characteristic of the people as of the government.

Lieut. Lecount in his "Treatise on Railways," says, "we have ourselves seen the land for one of the principal railways just constructed, paid for at the enormous sum of 5500*l.* per mile, and another at upwards of 330*l.* an acre, or about 5,600*l.* per mile, under all the circumstances of fraud, delusion, and downright robbery, that can any how be conceived. No means were left untried, no artifices unresorted to, and the most barefaced falsehoods unblushingly set forth, in aid of one vast system of plunder from beginning to end, with hardly any exception. They understand these things better in America. Juries there, have actually awarded, that landholders should compensate railway companies for bringing the line through their lands, whilst in England," etc. I hope Lieut. Lecount will omit the last sentence

in his next edition, and assure his readers, that by changing £ into $ the first part of the extract will apply at least as well on this, as on the other side of the Atlantic, and "with hardly any exception." He is right in stating, that these things are better understood in America, for, whilst in England they obtain exorbitant sums for loss of land, or other *actual* injury, here they receive large amounts because the company confer great value on lands which before were not worth their taxes. Seven thousand dollars per mile bears about the same proportion to the actual value of the land between Hartford and New Haven, that 40,000*l.* per mile does to the value of the land between London and Birmingham; and it is in this way, that they understand things better in America, not excepting her Majesty's Primier of Lower Canada.

I proceed to offer some remarks on the propriety of carrying a railroad *through* a village when it is possible *to pass* on the outskirts.

The only object in desiring a railway through a village, is to enhance for a short time the value of some private property, the owners of which, originally the most clamerous for the location, *after* selling out at an advance, will be the first to discover the *then* "intolerable annoyance" of having their streets traversed by locomotives, at all hours of the day and night. The great objection to such a location is, that the proprietors of the railway are completely in the power of a chamelion of corporation as to velocity and grade, and to some extent as regards the mode of construction.

By passing on the outskirts of a village, the inhabitants will be accommodated to the greatest possible extent, for, as the train stops only at one place, the citizens *generally*, in order to reach the depot, must traverse some distance more or less considerable in proportion to the magnitude of the place; they will consequently be equally well accommodated if the line be placed at this same distance from the main street, and will at the same time avoid all the inconveniences only too well known to those who have a railway close to their doors. A great space is required for buildings, turnouts, etc., for which, if in the village, the most exorbitant prices must be paid, whilst on the outskirts, land may be purchased by the acre and the entire business transacted in a manner much more to the advantage of the company, and of the public—the holders of corner lots always excepted.

It is seldom possible to adopt the most advantageous grades in a village. The rails must be laid so as to offer the least obstruction to waggons, the numerous crossings are as troublesome as they are expensive, and the proper drainage becomes in most cases impracticable. Then, in wet weather, the rails are covered with mud, which, by increasing the resistance of the train, and diminshing the adhesion or power of the engine, adds another difficulty to that often resulting from the unfavorable grade of the street. In winter again, by clearing the track of snow, the streets would be rendered almost impassible from the height of the snow from the railway track and side walks. In all such cases the proprietors of the railway will be fleeced, and by none with greater "*gout*," than by the very persons whose

previous representations induced them to neglect their interest and duty in placing the railway on ground not their own.

Before adopting a line through a street, when not absolutely necessary, the railway should be insured from all liability for damages on account of accidents to persons or cattle, from the expense of keeping the track clear of snow and mud, from the cost of construction and repairs of the *additional* work of the railway, crossings, drains, etc., and, as the danger from fire is well known, the risk should be borne by those who desire to bring into the midst of wooden buildings with shingle roofs, a machine vomiting forth showers of sparks every instant. Even then the millions who will pass over the road will be forever subjected to a loss of time by which incalculable injury will be inflicted on the railway. The trifling difference of 15 minutes in a journey of 150 miles on the Hudson, is sufficient to distance competition, as is known to all who travel on that river. There must be a very strong competition for the western road by the numerors grand thoroughfares which will eventually be made from all the great Atlantic cities to the interior, and speed will be the grand desideratum with *all*, and, however complacently the inhabitants of any one village may regard any unnecessary delay at their own place, they will be found at least as fierce as the western trader or European traveller in decrying the "disgusting delays" at the other 20 or 30 places in which they have no interest.

The interests and independence of the proprietors as well as the proper accommodation and reasonable fare which the public have a right to expect, imperatively require that the right of way should be obtained at a fair expenditure, that the company should be the owners and not the mere tenants of the railroad, and that the depots should if possible be located where the railway can never be controlled by village laws, and where any quantity of land likely to be required may be had at a trifling cost.

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In noticing the following extract from the New York Daily Express we feel gratified, not so much with the compliment paid us, as with the spirit of the article, which taking certain facts from our pages as a text, proceeds to remark upon them, and add further information.

Our daily press might do much for the cause of internal improvement, if, starting from dates and numbers, "the most stubborn of facts," judicious comments were made thereon, and the accumulated judgment and information of intelligent men added. Much credit is due to those gentlemen of this city who have fastened public attention to this all important topic, and from time to time have furnished popular views of the most exact results of professional men.

RAILROAD RECEIPTS.—In the August number of that valuable work, the Railroad Journal, we find it stated, that receipts on the Birmingham railway in England are now at the rate of 700,000*l* sterling, or $3,388,000 per annum. The dense population of England, and the use of railroads for *general transportation*, gives these enormous receipts. On our main lines in the United States the travel on railroads is rapidly on the increase.

The sanguine calculation of the most sanguine, *estimated for income*, the number to pass over "The Eastern Railroad" in Massachusetts at 116,700 for the first year. This period ended the 28th ult., and gave the actual number, 287,000, twice and a half the estimate. The railroads in Massachusetts, that are completed, generally exceed 7 per cent., nett income and are held above par.

The receipts on the Philadelphia, Wilmington and Delaware railroad, for June, July and August, was $127,000, and constantly on the increase.

The following statement of the receipts on the *Syracuse and Utica railroad,* which we understand cost $13,000 per mile for 53 miles, gives 9 per cent., gross in 74 days on the cost of this road:

| | | |
|---|---|---|
| Ending July | 6, (4 days,) | $2 594 41 |
| " | 13 | 5,356 11 |
| " | 20 | 5,854 30 |
| " | 27 | 5,537 15 |
| " Aug. | 3 | 5,300 11 |
| " | 10 | 5,744 87 |
| " | 17 | 5,953 35 |
| " | 24 | 5,444 89 |
| " | 31 | 6,189 42 |
| " Sept. | 7 | 6,330 17 |
| " | 14 | 6,507 37 |
| | | $61,312 15 |

Average per day $840—all for passengers.

We perceive that books are to be opened on the 15th, 16th, and 17th of October, to extend this road to Oswego, on Lake Ontario. This will be a favorite route to the Canadas, the Falls, and to the West. The gain in time and rest to the business man will be great. He sleeps on the North river, dines in Utica, takes tea in Oswego, or on board a fine steamer, and the next morning arrives in Lewistown, in time, if required, to take his breakfast in Buffalo by the railroad now in daily use. All this may be accomplished within forty hours from New York, without fatigue or loosing any rest.

From Syracuse to Auburn, 26 miles there is a very superior railroad completed at an expense of about $18,000 per mile, and doing a good business. Mr. Higham the Engineer in Chief of the Auburn and Rochester railroad, tells us that the entire line is under contract, and will be completed within two years. The Rochester and Tonawanda railroad is completed, and in use 33 miles, to Batavia, leaving a like distance to Buffalo to be completed. This part of the route is in the hands of a company, who have taken steps to procure the requisite funds to complete the only link in the chain from Albany to Buffalo.

The population in our own State tributary to this line—continued through the east parts of Columbia and Dutchess counties to this city—exceeds one million of souls. The day is not distant, when railroad lines will be extended to the Mississippi River, and the number of passengers passing through the valley of the Mohawk will equal 2,500 per day, or say $750,-000 for 300 days and yield a gross income of from 7 to $10,000,000 per annum at $12 fare from the city of New York to Buffalo, particularly if the State will allow this line to carry freight free of canal tolls.

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Building Material.—The sound sense displayed in the following article from the New York American, induces us to give it place although

treating of a topic of rather local interest. It is undoubtedly the case that too little attention is paid, in general, to the time enduring properties of the stone used in the construction of our public buildings. No one doubts the picturesque effect of broken cornices and time worn ornaments, but we prefer admiring the buildings of the present day in the perfection of uninjured sharpness of outline, leaving it to the next generation to contemplate them as beautiful ruins.

TRINITY CHURCH.

MR. EDITOR.—Understanding that it is in contemplation to rebuild Trinity Church with the red sandstone, permit me to call the attention of those concerned to a few remarks, in addition to those submitted through your columns a short time ago.

I take it for granted that the Church is now to be built in such a manner as not to need re-construction for at least a few centuries; and there is no good reason why it may not last one thousand as well as one hundred years. To insure this result, attention must be paid to the material employed in its construction. "In passing through the chief towns of Great Britain," says De la Beche, "it will easily be seen, that if more attention were paid to the mineralogical character of the stone employed in the construction of the buildings that frequent decay or decomposition even in those erected within a few years, which we so often observe, would be avoided, at comparatively small cost; and we should find fewer of our public edifices losing all traces of the finer work of their original structure. The number of cathedrals and other public buildings mouldering away externally, from inattention to the quality of the stone employed in them, is far greater than might be anticipated by those who have not directed their attention to the subject. Building materials for cathedrals, churches, abbeys, castles and the public edifices of towns, can scarcely in general be said to have been selected, except probably by the Normans; stone having been usually taken from the nearest quarry, provided it had a tolerable appearance, and was readily worked, it being left to accident whether the material so obtained were durable or not." Now, as we have the experience of older countries to guide us in the choice of building materials, as well as the necessary chemical and mineralogical knowledge which formerly were not possessed, there is no reason why, in the erection of our public buildings, we should blindly commit the same errors, as our (in this respect at least) less enlightened ancestors.

The question then is—should *sandstone* be selected for the construction of Trinity Church? I unhesitatingly say, no; and in this opinion, every competent judge of the character of this rock will coincide. Let us see what is said of it by our standard writers. "In the red sandstone series," says De la Beche, "the beds, with the exception of the conglomerates, [pudding stone,] are seldom sufficiently indurated to serve even for the commonest building purposes." "Sandstone," says Mahan, "is frequently so porous, as to absorb a large quantity of moisture, which, when acted upon by the frost, causes the surface of the stone to disintegrate, or to split off in scales. Sandstone has been used with us in the construction of our public works; in some cases as the principal material, but mostly for the cut stone of the angles, the coping, the water-tables, &c. Its inferiority to granite, and its liability to disintegrate, render it more suitable to ordinary structures; and its use is now mostly confined to edifices built principally of brick, or of rubble work. It should, moreover, only be used as ashlar, or cut stone, because it *adheres very badly to morter* and is, therefore, not suitable for rubble work, the principal strength of which depends on the adhesion be-

tween the stone and the morter." There is, however, a great difference in sandstone, as to durability, this being generally proportiond to its purely siliceous character, and its impermeability to water. Thus while some of the tomb-stones of red sandstone, in Trinity Church-yard have stood one hundred years or more, without much injury, others have scaled down to a thin sheet, the lettering being wholly gone. A chemist and practical geologist can only judge with accuracy as to the comparative durability of different specimens. Some of these sandstones have an argillaceous, and some a siliceous cement; while others have one of a furruginous nature. Those of the siliceous character are far the most desirable. But the best of the class are too perishable, to think of employing it for such a building as Trinity Church ought to be.

It is desirable, perhaps, that the color should be dark. If so, there are varieties of granite, called sienite, like that of which the Astor house is built, of a sufficiently sombre cast; and although the first cost might be considrably more, yet, when its durability is taken into account, it will be found far the cheapest in the end. It is to be hoped that so important a matter will not be acted on without due deliberation. PETROS.

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## PILE DRIVING BY STEAM.

In reply to the inquiry which has been often made, as to the original cost, cost of working, and utility of this machine, we give the following letter from Mr. Charles B. Stuart, civil engineer, now of the Syracuse and Oswego, but recently of the Syracuse and Utica railroad.

Mr. Stuart was resident engineer on the eastern division of that road; and had charge, for several months, of two of the machines; he therefore speaks from experience, and from a long and intimate acquaintance with him, one of the editors of this Journal can with the utmost confidence say, that his statements may be entirely relied upon—and also that he will cheerfully answer any inquiries from gentlemen desirous of more particular information, which may be addressed to him at Syracuse, N. Y.

SYRACUSE AND OSWEGO RAILROAD OFFICE,
*Syracuse, October* 7, 1839.

D. K. MINOR, ESQ.

Dear Sir,—Yours of September 30, asking information concerning the cost, economy, etc., of piled road, and the expense, power, etc., of steam pile drivers, as used upon the Syracuse and Utica railroad, is just received, and I take the earliest opportunity to give you the information desired on the subject. Below I copy from my late report to the commissioners of the "*Oswego and Syracuse Railroad*," an extract, in relation to that important improvement in railroad construction. "In low and marshy lands a piled road [similar to that so successfully introduced upon the Syracuse and Utica railroad,] is strongly recommended. On that road the piles are placed 5 feet longitudinally from centre to centre. Wherever there is an abundance of suitable piling timber, I should recommend a distance of four feet, as in this case a narrower tie might be used, and a sufficient reduction made in the size of timber, as very nearly to counterbalance the cost of the additional number of piles. The cost of piled road, is so entirely dependant on the

nature of the ground, and other circumstances which require time for examination, that I can, at present, furnish only an approximate estimate of its expense. It will, however, be entirely within bounds, to base our estimate on the data furnished by the Syracuse and Utica road. On that road the muck was of an average depth of 15 or 16 feet. In many places, piles were driven 25 and 30 feet, and in some instances over 50 feet deep. From the cursory examinations I have made on this road, I should judge the depth of muck generally, in the swamp, does not exceed 8 or 10 feet. The requisite piling timber is found contiguous to the route of this road, and it is evident to my mind, that this kind of structure can here be built cheaper than on the Utica and Syracuse road. On the eastern division of that road, of which I had charge, two piling machines were used, each manned with 6 or 7 men. In 5 1-2 months, the two machines drove 9 1-2 miles through a surfuce of muck, varying from 8 to 26 feet deep. On this road, under the favorable circumstances mentioned, a machine with 7 men, will have no difficulty in driving one mile per month. The wages of the men, including the incidental expenses of the machine, would not exceed $300 per month, thus furnishing, exclusive of timber, a mile of road, ready to receive the superstructure, and equivalent to a graded road with the sills laid, for $300, being less than the actual cost of hemlock sills, for a mile of graded road.

The piling system has, however, other advantages, besides economy of construction. It is not liable to derangement by *frost*. Piles in the most exposed situations on the Syracuse and Utica road, which have stood the frosts of *two winters*, abundantly prove this fact. It is also free from the expense and dangers incident to a graded road, in consequence of the washing of the banks by floods and rains, and settling when on a soft bottom, thereby requiring constant expense to adjust the road and replace the earth. I think it is not going too far, to say that the interest on the money saved by building a pile road, instead of a graded road, wherever the ground is applicable to such a structure, will renew the piles, if necessary, every five years.

The process of saturating the piles and timber of the superstructure with *salt*, can be applied at an inconsiderable expense. From the experiments made on the Syracuse and Utica road, the directors of that company are convinced of its utility, as an antiseptic, and I am informed that they are impregnating all their perishable materials of the superstructure with salt."

It may be well here to remark, that the piles used on the road to which I have referred, were from 12 to 18 inches in diameter, and the ties 4×12 inches. By the proposed reduction in size of timber, mentioned above, owing to their being placed one foot nearer together, piles 10 to 15 inches in diameter and ties 4×8 inches can be used, without impairing the strength of the road. On that road, white pine rails, 8 inches square, were used, in the place of which may be substituted yellow pine rails, 7×8 inches, and still afford a road of greater strength and durability, than when built upon the other plan.

Below, is given a bill of materials, omitting the piles, for one mile of pile road superstructure, together with their cost.

| | |
|---|---|
| 1320 Cedar ties, 8 feet long, 4×8 inches, *a* 30 *c.* | $396 00 |
| 2640 White elm tree nails, 1 foot long, 2 inches diameter, *a* 2 *c.* | 52 80 |
| 49,280 feet (board measure) yellow pine rails, 7×8 inches, *a* $15 | 739 20 |
| 4000 " " white oak ribbons, 1 1-4×3 inches, *a* $25 | 100 00 |
| 3960 cast iron knees, 1 1-2 lbs. each, = 5940 lbs., *a* 5 *c.* | 297 00 |
| 1320 " " " 2 lbs. each, = 2640 lbs., *a* 5 *c.* | 132 00 |
| 3200 lbs. pressed spikes, *a* 8 *c.* | 256 00 |
| 710 end plates, 1 lb. each, *a* 8 *c.* | 56 80 |
| 30 tons rail plate iron, 2 1-2×3-4 inches, [including transportation,] *a* $70, | 2100 00 |
| Distributing materials, | 100 00 |
| Workmanship, | 300 00 |
| Total, | $4529 80 |

In reply to your queries, as to the cost, power, and capabilities of the *steam pile driver*, I would briefly state, that the *cost* of the three machines used upon the Syracuse and Utica railroad, constructed at the extensive machine shops of Messrs. *Pond, Higham & Co.* of this city, were $2400 each, *complete.*

They have recently been much improved by them, and are *now* afforded at their shops, for $2250, ready for immediate use. Several have just been completed at their shops, destined for the State of Ohio.

These machines weigh, [including *two* hammers of 900 lbs. each,] about 5 tons. They are of *ten horse power*, with *two* 5 inch cylinders, 7 inch crank and 14 inch sweep. Whole length of boiler 12 feet—the part occupied by the *flues*, is 6 feet long and 2 feet diameter. The fire box is 4 feet long.

*Three* piston engines, and *one* rotary, are used on this railroad. The *rotary* was manufactured by E. Lynds & Son, Syracuse, and was quite successful.

At a comparatively trifling expense, the machines have been so altered, as to be advantageously used for sawing the *wood* for the locomotives on this road. They can also be profitably employed after the road is constructed, with slight alterations, in the machine shops of the company. When required again for use, the *leaders and necessary fixtures* are easily replaced, and the piling machine again put in full operation. With *leaders* 30 feet long, the hammers will strike from 4 to 5 times per minute, each, when in full motion.

The *average* number of 15 feet piles, driven in 10 or 12 feet muck, by a well managed machine, will be about 100 per day, including the sawing off of the *tops* to receive the rails. Piles, 25 feet long, driven in 20 feet muck, averaged 80 per day, for 60 days, although 120 piles, of this size, were driven by the same machine in 14 hours—and by another machine, 220

piles of 12 feet in length, were driven in the Mohawk river flats, in the short space of 13 hours.

The average length of the piles, on the Syracuse and Utica railroad, [in 19 1-2 miles of piled road,] was 18 feet. The cost of timber 2 1-2 cents per lineal foot, delivered, and the expense of driving, about $285 per mile, including the sawing off to the proper level of the road. If sawed off within two or three feet above the surface of the ground, no danger need be apprehended from *lateral* motion.

Too great care cannot be taken to have a competent and trusty foreman to take charge of these machines, it being very important for the safety of the road, to have the piles, in *every instance*, driven till they reach the hard, or solid bottom, thereby preventing any liability to settle, when passed over by the *heavy locomotives.*

In several instances, on the road alluded to, the substratum was found from 50 to 60 feet below the surface, and was reached by driving piles 30 feet in length, one upon another, and connecting them by a suitable pin at the joint. In every instance, when the bottom was found, not the slightest settling has been perceptible, and the experiment, so confidently made by this enterprizing company, has more than realized their highest expectations.

Any further information that you may desire on this subject, will be cheerfully furnished, by

Yours, truly,

C. B. STUART, *Civil Engineer.*

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The extraordinary interest which attaches itself to the discovery of M. Daguerre, induces us to give the following notice of it which is substantially correct, although wanting in minuteness of detail. The French government having purchased the secret by an annuity of 6000 francs per annum to M. Daguerre, and 4000 to M. Niepce, his coadjutor, have displayed a commendable example of national liberality, and encouragement of art and science.

Several persons in our city, have succeeded in obtaining very striking results, though not reaching the superior beauty of M. Daguerre's plates, in the manipulation of which, he has had years experience.

We need hardly remark, that the assumption of any exclusive knowledge or perfection in this art, by any individual, hinted at, if not directly claimed, in several of our papers, is entirely without foundation.

THE DAGUERREOTYPE.—It having been announced that the process employed by M. Daguerre, for fixing images of objects by the camera obscura, would be revealed on Monday at the sitting of the Academy of Sciences, every part of the space reserved for visitors was filled as early as 1 o'clock, although it was known that the description of the process would not take place until three. Upwards of two hundred persons who could not obtain admittane remained in the court yard of the palace of the institute. The following is an analysis of the description given on this occasion by M. Arago:—

The influence of light upon colors was known long ago. It had been observed that substances exposed to its action were affected by it; but beyond this fact nothing was known until 1566, when a peculiar ore of silver was discovered, to which was given the name of argent corne, and which had the property of becoming black when exposed to the light. Photographic science remained at this point until it was discovered that this argent corne (chloruret of silver) did not become black under all the rays of light. It was remarked that the red ray scarcely effected any change, whilst the violet ray was that which produced the greatest influence. M. J. Baptiste Porta then invented the camera obscura, and numerous efforts were made to fix the pretty miniature objects which were seen upon the table of it, and the transitory appearance of which was a subject of general regret. All thes efforts were fruitless up to the time of the invention of M. Niepce, which preceeded that of M. Daguerre, and led to the extraordinary result that the latter gentleman has obtained. M. Niepce, after a host of attempts, employed sheets of silver, which he covered with bitumen [*bitume de Judee*] dissolved in oil of lavender, the whole being covered with a varnish. On heating these sheets the oil disappeared, and there remained a whitish powder adhering to the sheet. This sheet thus prepared, was placed in the camera obscura, but when withdrawn the objects were hardly visible upon it. M. Niepce then resorted to new means for rendering the objects more distinct. For this purpose he put his sheets when removed from the camera obscura into a mixture of oil of lavender and oil of petroleum. How M. Niepce arrived at this discovery was not explained to us; it is sufficicient to state that after this operation, the objects became as visable as ordinary engravings, and it only remained to wash the sheet with distilled water to make the drawings permanent. But as the bitume de Judee is rather ash-colored than white, M. Niepce had to discover the means of increasing the shadows by more deeply blackening the lines [hachures.] For this purpose he employed a new mixture of sulphuret of potassium and iodine. But he [M. Niepce] did not succeed as he expected to do, for the iodine spread itself over the whole surface, and rendered the objects more confused. The great inconvenience, however, of the process, was the little sensitivenes of the coating [*enduit*] for it sometimes required three days for the light to produce sufficient effect. It will easily be conceived, therefore, that this means was not applicable to the camera obscura, upon which it is essential that the object should be instantaneously fixed, since the relative positions of the sun and earth being changed, the objects formed by it were destroyed. M. Niepce was therefore without hope of doing more than multiplying engravings, in which the objects being stationary are not affected by the different relative positions of the sun. M. Daguerre was devoting himself to the same pursuit as M. Niepce when he associated himself with that gentleman, and brought to the discovery an important improvement. The coating employed by M. Niepce had been laid on by means of a dabber, similar to the process used in printing, and consequently the coating was neither of a regular thickness nor perfectly white. M. Daguerre conceived the idea of using the residuum which is obtained from lavender by distilling it; and to render it liquid and applicable with more regularity, he dissolved it in either Thus a more uniform and whiter covering was obtained, but the object, notwithstanding, was not visible at once—it was necessary to place it over a vace containing some kind of essential oil, and then the object stood forth. This was not all that M. Daguerre aimed at. The tints were not deep enough, and this composition was not more sensative than that of M. Niepce. Three days were still necessary to obtain designs. We now come to the great discovery in the process for which M. Daguerre

has received a national reward. It is to the following effect:—A copper sheet, plated with silver, well cleaned with diluted mitric acid, is exposed to the vapour of iodine, which forms the first coating, which is very thin, as it does not exceed the millionth part of a metre in thickness. There are certain indispensable precautions necessary to render this coating uniform, the chief of which is the using of a rim of metal round the sheet. The sheet thus prepared, is placed in the camera obscura, where it is allowed to remain from eight to ten minutes. It is then taken out, but the most experienced eye can detect no trace of the drawing. The sheet is now exposed to the vapour of mercury, and when it has been heated to a temperature of 60 degrees of Reumer, or 167 Fahrenheit, the drawings come forth as if by enchantment. One singular and hitherto inexplicable fact in this process is, that the sheet, when exposed to the action of the vapour, must be inclined, for if it were placed in a direct position over the vapour the results would be less satisfactory. The angle used is 48 degrees. The last part of the process is to place the sheet in the hyposulphate of soda, and then to wash it in a large quantity of distilled water. The description of the process appeared to excite great interest in the auditory, amongst whom we observed many distinguished persons connected with science and the fine arts.

Unfortunately the locality was not adjusted suitable for the performance of M. Daguerre's experiments, but we understand that arrangements will be made for a public exhibition of them. Three highly curious drawings obtained in this manner were exhibited; one of the Pont Marie; another of M. Daguerre's atelier; and a third of a room containing some rich carpeting, all the minutest threads of which were represented with the most mathematical accuracy, and with wonderful richness of effect.—*London Globe of* 23 *Aug.*

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INSTITUTION OF CIVIL ENGINEERS.—IMPROVED LEVELLING STAFF.

Mr. Bruff exhibited an improved form of Levelling Staff. The figures on this staff are inverted, so that when viewed by an inverting telescope, in the usual manner, they appear erect, and are read off without any danger of mistake; which may readily occur when some figures, as for instance, 6 and 9, are read off inverted. The mechanical arrangements for extending it are with the view of securing greater steadiness. The principal improvement consists in their being attached to the bottom an universal joint, fixed to an iron plate; this plate remaining fixed, the necessary errors consequent on moving the staff for reversing its face, when the last forward station is to become the next back, are avoided.

It was suggested that the universal joint would be attended with great advantages in sloping ground; in general, however, the tripod invented by Mr. Simms was sufficiently convenient.

Mr. Bald suggested that the universal joint would be extremely servicable if placed on something solid. It was his practice to drive a wooden plug into the ground, on which the staff was set; these plugs were left in, and servicable for verifying the observations. He had levelled through a distance of forty miles, leaving a plug at every station.

EXPERIMENTS ON THE FLOW OF WATER THROUGH PIPES OF DIFFERENT LENGTHS.—BY W. A. PROVIS, M. INST. C. E.

In this paper are recorded *two hundred and eight* experiments on the flow of water through leaden pipes of $1\frac{1}{2}$ inch diameter, of lengths 100, 80, 60 and 40 feet, and for heads of water of 35, 30, 24, 18, 12, and 6 inches. The arrangement of the experiments is described with great accuracy, and the results of the experiments are given in twelve tables, showing the length

and inclination of the pipe, the head of water at the upper end of the pipe, the time from turning the water into the upper end of the pipe, to its reaching the lower end, the time of filling the receiver, the discharge in cubic feet per minute, and the mean discharge per minute. To each set of experiments is appended a column of remarks, in which the state of the pipe as to dryness, and the quantity of water in the discharging end, are recorded; these circumstances having considerable influence on the quantity of the discharge.

The experiments are tabulated in a different form, showing the effect of a given head of water in pipes of different lengths and inclinations. The following important results are deduced. In level pipes the quantity of water discharged is nearly in the inverse ratio of the square root of the length; but the departure from this rule is greatest in the shortest lengths and greatest heads. In inclined pipes, the increased discharge is greater in the long than in the short pipes. The increased discharge for an increased head is nearly in the same proportion through the long and short lengths.

TABLE OF GRADIENTS.—BY C. BOURNS, A. INST. C. E.

| per mile. | | | | | per chain. | | per mile. | | | | | per chain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ft.= | 1 in | 5280 | = | .15 | of an in. | 31 | ft.= | 1 in | 170.3 | = | 4.65 | of an in. |
| 2 | “ | “ | 2640 | “ | .30 | “ | 32 | “ | “ | 160.0 | “ | 4.80 | “ |
| 3 | “ | “ | 1760 | “ | .45 | “ | 33 | “ | “ | 150.0 | “ | 4.95 | “ |
| 4 | “ | “ | 1320 | “ | .60 | “ | 34 | “ | “ | 155.3 | “ | 5.10 | “ |
| 5 | “ | “ | 1056 | “ | .75 | “ | 35 | “ | “ | 150.8 | “ | 5.25 | “ |
| 6 | “ | “ | 880 | “ | .90 | “ | 36 | “ | “ | 146.6 | “ | 5.40 | “ |
| 7 | “ | “ | 754.2 | “ | 1.05 | “ | 37 | “ | “ | 142.7 | “ | 5.55 | “ |
| 8 | “ | “ | 660.0 | “ | 1.20 | “ | 38 | “ | “ | 138.9 | “ | 5.70 | “ |
| 9 | “ | “ | 586.6 | “ | 1.35 | “ | 39 | “ | “ | 135.4 | “ | 5.85 | “ |
| 10 | “ | “ | 528.0 | “ | 1.50 | “ | 40 | “ | “ | 132.0 | “ | 6.00 | “ |
| 11 | “ | “ | 480.0 | “ | 1.65 | “ | 41 | “ | “ | 128.8 | “ | 6.15 | “ |
| 12 | “ | “ | 440.0 | “ | 1.80 | “ | 42 | “ | “ | 125.7 | “ | 6.30 | “ |
| 13 | “ | “ | 406.1 | “ | 1.95 | “ | 43 | “ | “ | 122.8 | “ | 6.45 | “ |
| 14 | “ | “ | 377.1 | “ | 2.10 | “ | 44 | “ | “ | 120 0 | “ | 6.60 | “ |
| 15 | “ | “ | 352.0 | “ | 2.25 | “ | 45 | “ | “ | 117.3 | “ | 6.75 | “ |
| 16 | “ | “ | 330.0 | “ | 2.40 | “ | 46 | “ | “ | 114.8 | “ | 6.90 | “ |
| 17 | “ | “ | 310.6 | “ | 2.55 | “ | 47 | “ | “ | 112.3 | “ | 7.05 | “ |
| 18 | “ | “ | 293.3 | “ | 2.70 | “ | 48 | “ | “ | 110.0 | “ | 7.20 | “ |
| 19 | “ | “ | 277.9 | “ | 2.85 | “ | 49 | “ | “ | 107.7 | “ | 7.35 | “ |
| 20 | “ | “ | 264.0 | “ | 3.00 | “ | 50 | “ | “ | 105.6 | “ | 7.50 | “ |
| 21 | “ | “ | 251.4 | “ | 3.15 | “ | 51 | “ | “ | 103.5 | “ | 7.65 | “ |
| 22 | “ | “ | 240.0 | “ | 3.30 | “ | 52 | “ | “ | 101.5 | “ | 7.80 | “ |
| 23 | “ | “ | 229.5 | “ | 3·45 | “ | 53 | “ | “ | 99.6 | “ | 7.95 | “ |
| 24 | “ | “ | 220.0 | “ | 3.60 | “ | 54 | “ | “ | 97.8 | “ | 8.10 | “ |
| 25 | “ | “ | 211.2 | “ | 3.75 | “ | 55 | “ | “ | 96.0 | “ | 8 25 | “ |
| 26 | “ | “ | 203.1 | “ | 3.90 | “ | 56 | “ | “ | 94.3 | “ | 8.40 | “ |
| 27 | “ | “ | 195.5 | “ | 4.05 | “ | 57 | “ | “ | 92.6 | “ | 8 55 | “ |
| 28 | “ | “ | 188.6 | “ | 4.20 | “ | 58 | “ | “ | 91.0 | “ | 8.70 | “ |
| 29 | “ | “ | 182.1 | “ | 4.35 | “ | 59 | “ | “ | 89.5 | “ | 8.85 | “ |
| 30 | “ | “ | 176.0 | “ | 4.50 | “ | 60 | “ | “ | 88.0 | “ | 9.00 | “ |

DESCRIPTION AND DRAWING OF THE ICE BOAT.—BY S. BALLARD, A. INST. C. E.

The principle of breaking ice adopted by Mr. Ballard, as explained in a communication made last session, consists in forcing the ice upwards instead of forcing through it horizontally, or by pressing it down. for this,

purpose a frame, coated with sheet iron is laid over the front of a boat with an inclination downward from the boat, the lower end being under the ice. The paper describes the construction of the boat by reference to to a detailed drawing and section.

ON THE CONSTRUCTION OF ROADS ON DEEP BOGS AND MOSS.—BY W. BALD.

In this paper the author gives a detailed account of the construction of roads through bogs, and of the methods of securing the foundations of small bridges in boggy places; also some suggestions on the formation of railways on deep moss.

The general principles are as follows:—The first operation after laying out the line of road is to drain thoroughly the bog over which it is to pass. For this purpose main drains and counter drains parallel to the line of road are to be cut with a regular discharging fall along the bottom. Transverse drains must also be cut betwixt the main and the counter drains, so as effectually to drain off all the surface water and stagnant pools. The cutting of these drains must be carried on gradually, and by degrees; if the bog be moist, the opperations, which can only be carried on at dry seasons of the year, will probably have to be continued over three or four years before the drains become permanently fixed at the required dementions. The counter drains are essential, as they relieve the pressure on the sides of the main drain, and consequently prevent it filling up. The bog stuff cut out is to be dried, and when the bog under the line of road has become sufficiently dry, the road is to be levelled, and made of propper shape, and the cross drains are to be filled with dry turf.

The road-way is then to be floored or trunked over with five courses of dry heathy sods, which are to be well rolled with a heavy cylinder.—Upon this trunking is to be laid a soiling, consisting of a mixed mass of prepared earth and gravel, of about six inches in thickness, and the whole to be coated with good clean gravel. The road metal is then to be laid on, in two successive coats, each of about three inches in thickness, the first being well consolidated before the second is laid on.

The great points to be aimed at, are perfect drainage and good trunking, as, if these are not attained, roads constructed on bog will lose their shape, become ruinous, and soon go to decay.

The author considers the form and size of hammers employed in breaking hard stones.

These are frequently too heavy; a hammer weighing about a pound and a quarter, of an elliptical form, pointed at the ends, the area of end being about one hundredth part of a square inch, appears to be best suited for ordinary purposes.

The turf of bog, being carbonized, makes excellent fuel, and may be employed in the manufacture of iron, and such iron is extremely malleable. Turf fuel is also used most extensively in working the steam engine in many districts of Ireland; it is used on board the Dunally steam boat, for engines of eighteen horse power, and the expense is four pence per mile.

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CHARLESTON AND CINCINNATI RAILROAD.—At a meeting of the Chaleston and Cincinnati Railroad Company, at Ashville, N. C., on the 16th, inst., a resolution was passed to suspend all works beyond Columbia until the road to that place be first made, and also another resolution, that the States interested in the project be informed that the road must stop at Columbia, unless they come to its assistance.

It is understood that the aid of the States in question will not be granted, and consequently the road must stop at Columbia.

THE OHIO RAILROAD.—We have had occasion within the past few weeks to allude to this work. The following extract from a letter received this morning, will give our readers some idea of its progress, and the plan of its construction.

*Lower Sandusky, July 15th,* 1839.

The business of the company is now principally confined to the two first divisions of the road, extending from Manhattan to Maumee river, through the Black Swamp, to this place, a distance of thirty miles. The road is cleared and grubbed ready for driving the piles the whole distance. The piles, 76,680 in number, are on the line ready for use. The several contracts for the delivery of the ties are in part completed and in full progress. The trestle bridge, 90 feet in length, near this place, and a similar bridge, 390 feet long across Muskalunge creek, are completed, and timber for the balance of the bridging on these two sections is on the ground.

The company now have in successful operation two of Crane's patent steam pile drivers, one at this place going west, and one at Maumee coming east. They will drive about 100 piles each per day, and as the piles are driven five feet from centre to centre, each machine will make fifteen rods of road per day. They drive two rows at once, or two piles at a time. I am confident they will make a more permanent and much cheaper road than can be made in any other way. We have also two cars which follow the pile drivers, in which the workmen eat and sleep. They are 24 by 14 feet, commodious and airy, with a kitchen and dining room, which at night is occupied as a sleeping room. We are now building some freight cars for the purpose of more conveniently transporting timber, provison, etc. A portion of the track is cleared, and piles and timber are on the line of the two next, or third and fourth divisions, extending from this place to Huron. In short, everything appears to be going ahead, with that spirit of energy which shows a determination on the part of the company to complete the road with the least possible delay and in the best manner.—*Buffalo Commercial Advertiser.*

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## THE READING RAILROAD: ITS ADVANTAGES FOR THE CHEAP TRANSPORTATION OF COAL, AS COMPARED WITH THE SCHUYLKILL NAVIGATION AND LEHIGH CANAL. BY MR. EDWARDS.

(Continued from page 190.)

### READING RAILROAD.—NO. VII.

The ability of the locomotive engines to perform the full number of trips stated in No. III., as the annual work for each engine on the Reading railroad engaged in drawing the coal cars, will now be examined.

The work for each engine was there estimated at 100 full trips annually, with 150 tons of coal at each trip, or in all, 15,000 tons of coal *per annum.* The distance from Pottsville to the Delaware and returning, for each trip would be 188 miles; or, in all, for 100 trips, 18,800 miles. The load would average for the whole distance 75 tons, or be equal to 75 tons carried 18,800 miles, or 1,410,000 tons carried one mile.

*The great advantage of the Reading railroad is, its unparalleled grades*—thus, for example: were the grades of the Reading railroad occasionally ascending from the mines, yet not exceeding 40 feet per mile, [the grade that has very generally been admitted on our railroads] the power that is only sufficient to draw on the Reading railroad from the mines to this city, over the levels and descents of that road, 150 tons of coal, in say 50 cars weighing 75 tons, in all 225 tons, would be barely able to draw 45 tons of coal in 15 cars weighing 22 1-2 tons—in all 67 1-2 tons. And

the engine performing her full number of trips, 100 annually up and down, would bring but 4,500 tons *per annum*. The distance travelled would be the same [say 18,800 miles.] The load would average for the whole distance 22 1-2 tons, or equal to 22 1-2 tons carried 18,800 miles, or 423,000 tons carried 1 mile.

The ability of the engines on the Reading railroad, as to the number of miles *per annum*, which I have taken as the basis for the estimate of the cost per ton for motive power in No. III., was, as above stated, 18,800 miles; which is below the average of ten of the best engines owned by the Liverpool and Manchester railway company. They, it will be seen, averaged, during the year 1831, 18,265 miles each; during the year 1832, 19,372 miles each; during the year 1833, 22,011 miles each, or equal during the year 1831, to 97 full trips on the Reading railroad, during the year 1832, to 103 full trips; during the year 1833, to 117 full trips. It will also be seen that during the first twelve weeks of 1834, the average number of miles travelled weekly by each engine, was increased from 438 miles, the average of 1833, to 538 miles, which, for 52 weeks, would be 27,976 miles *per annum*, or equal to 149 full trips on the Reading railroad.

From this it will be seen, that engines travelling at high velocities, on the Liverpool and Manchester railroad, and therefore, much more liable to get out of repair, than engines travelling at low velocities, [besides, they perform only 30 mile trips in continuation, whereas, on the Reading railroad, the engines will perform 94 miles in continuation] were nevertheless able to travel during the year 1833, the Jupiter 31,582 miles, the Ajax 26,163 miles, the Firefly 24,874 miles, and so down to the Etna 17,763 miles, and that they averaged upwards of 22,000 miles for each engine, during that year.

The Chevalier de Pambour concludes the article I am about to extract from his valuable work, with these words: "This statement shows what can be expected from locomotive engines, when constructed with care and of good materials, and there is no doubt that, in time, more work will still be obtained from them." This was written in 1834. Since that period locomotive engines have been improved, and are now, owing to more perfect construction, much less liable to get out of repair than formerly.

Why, then, do we not realize the full advantages of locomotive power? The answer is obvious—instead of adapting our railroads to locomotive power, we adapt them to our limited cash means, and hence there are up and down grades, according to the surface of the country, through or over which the railroad passes. Our economy in the original outlay, entails upon us an increased cost for locomotive power, more than equal, where the trade is large, to the interest upon a sum that would have been sufficient to make a proper railroad.

It is here, that the projectors of the Reading railroad have shown correct judgment and prudent foresight; for the trade they were to compete for required that the cost of transportation should be low. It might have been questioned, whether the large outlay of money could be justified; the result of their deliberation we have before us, in the most perfect grades for cheap railroad transportation in the world, and a consequent ability to transport at the lowest possible cost per ton.

There is perhaps no better authority than the Chevalier de Pambour on the subject of railroads and locomotive power. Much of his time was devoted to their study, and the result of his labors is a standard work, referred to at all times with confidence. From it I extract the following:

"In order to execute this haulage [gross weight of goods and cars 233,-114 tons; gross weight of passengers and cars 140,662 tons; in all 373,-776 tons] the engines made 6570 journeys, drawing stage coaches, that is to say, with a velocity of 20 miles an hour, and 5086 journeys with goods, or with a velocity of 12 1-2 miles an hour—the average velocity of the haulage was consequently in miles per hour 16 73-100 miles.

"We have said elsewhere, that the Liverpool and Manchester railway company possesses at present thirty locomotive engines. It must not be concluded, however, that that number is necessary in order to execute the above said haulage; of these 30 engines, about one third are useless; they are the most ancient, which having been constructed at the first establishment of the railway, at a time when the company had not yet obtained sufficient experience in that respect, are found now to be out of proportion with the work required of them. The engines actually in daily activity on the road, amount to about 10 or 11, and with an equal number in repair or in reserve, the business might completely be ensured; this is in fact what happens at present, the surplus above that number being nearly abandoned.

"We shall complete what we have just been saying on the Liverpool locomotive engines, by adding a document, that will show, what these engines are capable of executing in a daily work, and the improvement they have undergone in the course of the last few years in respect to the solidity of their construction.

"*Work done by the ten best engines of the Liverpool and Manchester railway, during the years* 1831, 1832, 1833, *and the first twelve weeks of* 1834.

| Year | Name of engine. | Total distance travelled. | Total time in use or repair. | Year | Name of engine. | Total distance travelled. | Total time in use or repair. |
|---|---|---|---|---|---|---|---|
| | | miles. | weeks. | | | miles. | weeks. |
| 1831 | Mercury, | 23,212 | 52 | 1832 | Vulcan, | 26,053 | 53 |
| | Jupiter, | 22,528 | 44 | | Liver, | 22,651 | 43 |
| | Planet, | 20,404 | 52 | | Venus, | 20,464 | 52 |
| | Saturn, | 19,510 | 38 | | Etna, | 20,399 | 52 |
| | Mars, | 18,645 | 50 | | Saturn, | 20,312 | 52 |
| | Majestic, | 18,253 | 52 | | Vesta, | 17,739 | 52 |
| | North Star, | 15,677 | 52 | | Victory, | 17,082 | 52 |
| | Northumbrian, | 15,607 | 52 | | Planet, | 16,885 | 52 |
| | Phœnix, | 15,405 | 52 | | Sun, | 16,535 | 52 |
| | Sun, | 13,434 | 37 | | Fury, | 15,603 | 52 |
| | Sum, | 182,675 | 481 | | Sum, | 193,723 | 511 |
| | Aver. pr week, | 380 | | | Aver. per week | 379 | |
| 1833 | Jupiter, | 31,582 | 52 | 1834 | Firefly, | 8,542 | 12 |
| | Ajax, | 26,163 | 52 | | Vulcan, | 8,526 | 12 |
| | Firefly, | 24,879 | 39 | | Saturn, | 7,290 | 12 |
| | Liver, | 23,134 | 52 | | Liver, | 7,080 | 12 |
| | Pluto, | 20,308 | 52 | | Sun, | 7,080 | 12 |
| | Vesta, | 19,838 | 52 | | Etna, | 6,557 | 12 |
| | Leeds, | 19,364 | 48 | | Leeds, | 5,712 | 12 |
| | Saturn, | 18,738 | 52 | | Ajax, | 4,890 | 12 |
| | Venus, | 18,348 | 52 | | Venus, | 4,632 | 12 |
| | Etna, | 17,763 | 52 | | Pluto, | 4,246 | 12 |
| | Sum, | 220,117 | 503 | | Sum. | 64,555 | 120 |
| | Aver. pr week, | 438 | | | Aver. per week | 538 | |

"Among those engines the Liver had worked for 107 weeks, had travelled 52,865 miles, or on an average 494 miles a week, during all that time. The Firefly had worked 57 weeks, had travelled a distance of 33,421 miles, or 586 miles a week, and neither of these engines, at the period in question, had yet required a fundamental repair.

"This statement shows what can be expected from locomotive engines

when constructed with care and of good materials, and there is no doubt that in time more work will still be obtained from them."

The total work for each engine, as estimated in No. III., being 18,800 miles annually, from the above table it will be seen that in each year's operations on the Liverpool and Manchester railroad, their average was beyond it, with the single exception of the first year; and even this is accounted for by the fact, that the Jupiter was only 44 weeks in use, the Saturn 38, and the Sun 37 weeks [they not being finished at the commencement of the year].

### READING RAILROAD.—NO. VIII.

As regards the amount of business for this railway, when finished, some opinion may be formed from examining what amount has actually been paid on the Schuylkill navigation for freight and toll during the last four years.

| | |
|---|---:|
| During the year 1835, the total amount of tonnage per the Schuylkill Navigation was 535,194 tons, the greater part of which passed through the whole length of the canal; say equal to 471,352 tons passed the entire distance, which, at a toll of 92 cents per ton, gives a total receipt for tolls of | $433,643 |
| The freight on coal, during this year, 1835, averaged $1 19 per ton; if therefore we assume this as the average freight on all that passed through the canal, it gives for freight on 471,352 tons at $1 19 per ton, | 560,908 |
| | $994,551 |

Being for freight and tolls during 1835, nine hundred and ninety-four thousand, five hundred and fifty-one dollars.

This sum, paid to the Reading railroad company during the year, for freight and toll on the same number of tons would give [estimating 300 working days in the year] a *daily receipt of three thousand, three hundred and fifteen dollars.*

| | |
|---|---:|
| During the year 1836, the total amount of tonnage was 631,173 tons; say equal to 568,079 tons passed the whole length of the canal, which, at a toll of 92 cents per ton, gives a total receipt for tolls of | $522,633 |
| The freight on coal during 1836, averaged $1 50 1-2 per ton; assuming this as the average, we have for freight, 568,079 tons at $1 50 1-2 per ton | 854,958 |
| | $1,377,591 |

Being for freight and tolls during 1836, one million, three hundred and seventy-seven thousand, five hundred and ninety-one dollars.

This sum, paid to the Reading railroad company during the year, for freight and toll on the same number of tons, would give [estimating 300 working days in the year] a *daily receipt of four thousand, five hundred and ninety-two dollars.*

| | |
|---|---:|
| During the year 1837, the total amount of tonnage was 726,730 tons; say equal to 656,727 tons passed the whole length of the canal, which, at a toll of 92 cents per ton, gives a total receipt for tolls of | $604,189 |
| The freight on coal during 1837 averaged $1 27 1-4 per ton; assuming this as the average, we have for freight, 656,727 tons at $1 27 1-4 per ton, | 835,685 |
| | $1,439,874 |

Being for freight and tolls during the year, 1837 one million, four hundred and thirty-nine thousand, eight hundred and seventy-four dollars.

This sum, paid to the Reading railroad company during the year for freight and toll on the same number of tons would give [estimating 300 working days in the year] *a daily receipt of four thousand, seven hundred and ninety-nine dollars.*

During the year 1838, the total amount of tonnage was 643,633 tons; say equal to 549,295 tons passed the whole length of the canal, which, at a toll of 92 cents per ton, gives a total receipt for tolls of $505,351

The freight on coal, during 1838, averaged $1 16 per ton; assuming this as the average, we have for freight 549,295 tons at $1 16 per ton $1,142,533

Being for freight and tolls during the year 1838, one million, one hundred and forty-two thousand, five hundred and thirty-three dollars.

This sum, paid to the Reading railroad company during the year, for freight and toll on the same number of tons, would give [estimating 300 working days in the year] *a daily receipt of three thousand eight hundred and eight dollars.*

Thus it will be seen, that there has actually been paid during the year 1835, $994,551; during the year 1836, $1,377,591; during the year 1837 $1,439,874; and during the year 1838, $1,142,553, for freight and toll on the Schulkill navigation, estimating the freight on merchandize etc., the same as on coal, whereas the charge for freight on articles other than coal is much higher; which, had it been included, would have further swelled these already large amounts.

It is for this immense trade that the Reading railway is intended to complete—its ability to transport at a lower rate than either the Schuylkill navigation or Lehigh canal, and consequently to secure to itself the whole of that trade, has we think, been fully demonstrated in the foregoing numbers. Unlike many of our public works, which have been undertaken before the amount of travel or transportation was sufficient to justify the outlay, the Reading railroad comes into the field to secure a trade already established, vast indeed in the amounts annually paid for transportation, but as yet comparatively in its infancy.

Another important consideration in regard to this valuable improvement is, whether, when it shall have realized what is now so confidently predicted, it can itself be hereafter interfered with by any rival undertaking.

It is therefore important to show that the danger from future rivalry, thus stimulated, was not overlooked by the projectors of this road, and that there is good ground for believing that it cannot hereafter be superseded by any known means of transportation.

On the immediate line of the road from Pottsville to Philadelphia, following, as it does, the valley of the Schuylkill, the best points and the most favourable ground for the road have been adopted; and when we take into consideration the minute and careful examination of the country made by the distinguished engineers of the road before the rout was finally located, their declaration that "they have so pre-occupied the ground as entirely to exclude another feasible location" will be readily believed; while independently of the natural obstacles, the already immense capability of the road could be so much increased by laying two additional tracks, as would of itself effectually prevent all interference.

For the supply of the city of New York, Brooklyn, and the towns on the north river, etc., various lines of canals from the Delaware have been in

operation for sometime, viz: the Delaware and Hudson canal capable of passing boats with an average load of 30 tons; the Morris canal from Easton to Jersey city, one hundred and one miles long, capable of passing boats with an average load of 22 tons; and the Delaware and Raritan canal, from Bordentown to New Brunswick, 43 miles, and thence 45 miles by river to New York; this last named canal is capable of passing boats with 200 tons.

The coal passing through the Morris canal has to come through the Lehigh canal, from Mauch Chunk, 46 miles to Easton, and thence by that canal to Jersey city opposite New York.

The coal to pass through the Delaware and Raritan canal has to come through the Lehigh canal 46 miles, and thence 60 miles through the State canal to Bristol, in boats averaging 52 tons, where it is loaded into the barges carrying 200 tons, thence 10 miles by the river Delaware to Bordentown, where it enters the Delaware and Raritan canal for New York.

A line of railroad from Easton to Jersey city has also been surveyed; but owing to the high grades required [40 to 60 feet being nesessary for considerable distances] it has been deemed impracticable to construct one through that country capable of carrying coal in competition with the Delaware and Raritan canal; for it will readily be seen that in making a railroad to carry coal from Easton to Jersey city, the competition would not be with the Morris canal, passing boats with only 22 tons, but with the Delaware and Raritan canal passing boats with 200 tons.

Had such an improvement as the Delaware and Raritan canal been practicable between Philadelphia and Pottsville, the Reading railway would probably never have been undertaken; or at least not until the increase of business would have allowed profitable occupation to both.

A natural connection may be said to exist between the Reading railroad and the Delaware and Raritan canal, for as the capacity of an engine and train on the Reading railroad is 200 tons, and the capacity of the boats on the Delaware and Raritan canal the same, they will together form a continuous line of inland transportation, cheaper than any other, for coal and heavy freights.

Having thus far confined myself chiefly to an examination of the capability of the Reading railroad as a COAL RAILWAY, it may be necessary hereafter to examine how far the value of the improvement may be enhanced as a line for the conveyance of passengers and merchandize, when the various railroads proposed to connect with this road shall be completed.

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## REPORT OF THE DIRECTORS OF THE EASTERN RAILROAD COMPANY IN NEW HAMPSHIRE.

*To the Stockholders of the Eastern Railroad Company, in New Hampshire, at their annual meeting to be holden at Portsmouth Sept.* 4, 1839.

The Directors of said company respectfully report,—That after the election of the major part to the present Board of Directors, the attention of the Board was turned to a re-location of the road, from the line of Massachusetts to Portsmouth. On examining the surveys formerly made under the direction of Mr. Barney, the Board were satisfied that these, for want of time, were not so minute and thorough as the importance of a proper selection of the route demanded. They therefore directed a re-survey of the country, through which the road is to pass, and an examination of all the routes which have been heretofore examined or suggested.

The railroad company in New Hampshire was incorporated a few months after the eastern railroad company in Massachusetts, the route

of whose road passes through Newburyport to the line of New Hampshire, at Salisbury, and was authorized to build a road from Salisbury or Seabrook (the adjoining town) to Portsmouth. It was evidently the intention of the legislatures of the two States, that the line of road should be continuous from Boston to Portsmouth; and the road in Massachusetts must, by the charter, cross the Merrimack river at, or near the scite of the present Newburyport bridge. This point therefore, must form one terminus of a road from the Merrimack to the Piscataqua. By the provisions of the act of the last sesion of the legislature of New Hampshire, authorizing a re-location of the line of the road, the terminus in Portsmouth is fixed at or near the Universalist church in that town. This act having been accepted by the company, of course fixes the eastern terminus. The termini of the road being thus determined, the action of the directors was confined to the selection of the most practicable and preferable route for a railroad between them:--and however desirable it might be to have had the whole route open both in its course and termini, for the unembarrassed action of the directors—yet they believe that the most eligible route, under existing restrictions, has been selected.

The report of Col. Fessenden, the engineer of the road, on the subject of the location, has been presented to the directors, and been very fully examined and considered by them, and the route recommended by him has been adopted.

This route leaves the Merrimack river at the Newburyport bridge—thence passing over Salisbury marsh, westwardly of the county road, and the village at old Salisbury, comes to the State line at a point a little eastwardly of the main road. At this point the location in New Hampshire commences--and crossing little marsh and passing about one third of a mile eastwardly of the village at Hampton Falls, crosses the main road westwardly of Hampton Falls landing, and then the marshes, to old Hampton village, running near the stage road—thence through the swamp near the school house, and over the western point of breakfast hill, to cedar swamp in Greenland—and thence by Messrs. Young's and Hussey's, crossing the Greenland road above the plains—and thence curving lightly to the right, crosses the Islington and Middle roads, and Joshua street, to the mill pond—thence over the pond to the depot, near the Universalist church.

The line thus run is fifteen miles and 2570 feet in length in New Hampshire. It is composed, for most of its length, of four straight lines, connected by short favorable curves, of a mile radius. It passes over a face of country remarkably favorable for a railroad route, requiring no inclinations greater than 35 feet per mile—and that for one plane only, the rest being 30 feet per mile and under;—nearly all the important roads in the vicinity of Portsmouth admitting of independent crossings.

Another route running eastwardly of the one above described, and pursuing a course from one half to about two and a half miles distant, was also surveyed and reported upon. This also may be considered a favorable route as to grades, and the ground over which it passes. In distance, it is about half a mile shorter, in inclinations somewhat less, than the route selected, and has a straight line of about nine miles, the remainder being much curved. The comparison of the two routes in relation to directness and freedom from curves, is decidedly favorable to the route selected, which has ninty-nine degrees, while the eastern route has 298 degrees of curvature.

In forming their judgment, as to which of these two lines should be selected, the directors were influenced by the considerations:—

First, that while either route would pass from one termini to the other, without materially obstructing the travelled roads, the route selected would in addition, pass above the navigation of all the rivers, while the eastern route would cross two or three streams, where draws would be necessary.

Second, the marsh embankment on the selected route will be much less exposed to the action of the sea and ice, than that upon the eastern route.

Third, there is much less bridging subject to decay, upon it, than upon the eastern route.

Fourth, the estimated expenses of the two routes is about twelve thousand dollars in favor of the selected route, and

Fifth, and chiefly, the selected route, by embracing and commanding the travel of a broader belt of country, will, while it gives larger accommodations to the public, secure a greater amount of travel.

The route being selected, and proposals advertised for, and received; the grading and masonry of the line has been contracted for on favorable terms, with Messrs. Sewall F. Belknap, of Beverly, and Samuel Turner, of Dedham, in one contract, who have engaged to complete the same, ready for the superstructure, half by first of April, and the remainder by the first of June next. The directors have the greatest confidence in these contractors, and believe the work will be done in a workmanlike manner, and within the stipulated time. Arrangements have been made for procuring the rail iron; the fencing is already under contract and proposals are being received for the under sills, sleepers, spikes, keys, etc.

Negotiations have been commenced for the settlement of land damages, procuring lands for depots, etc. And the directors confidently believe that the road may be completed for use early the next season.

All which is respectfully submited. *In behalf of the Directors.*

B. T. Reed, *President pro tem.*

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**REPORT AND PLAN OF THE SURVEYS AND DEFINITE LOCATION OF THE EASTERN RAILROAD IN NEW HAMPSHIRE.—BY JOHN M. FESSENDEN, CIVIL ENGINEER.**

*To the President and Directors of the Eastern Railroad Company in New Hampshire.*

Gentlemen,—Previously to the re-organization of your company, at the request of the directors of the eastern railroad company in Massachusetts, I made, accompanied by my assistant Mr. Wilder, a particular examination of the country through which your road is to be constructed. The result of this examination was a conviction that a much more favorable location might be made than there had been by the previous surveys. Immediately after this examination, the levels and direction of the most favorable eastern and western line were obtained, and they fully confirmed the opinion which I had formed.

After the re-organization of your company, agreeably to your instructions I directed the lines of location to be run; advertised for proposals for the grading, etc., of the road, and hastened to prepare the work for the contractors, and I have now to report on the different lines located, as follows: referring to the accompanying plans and profiles.

The western line as located, after leaving Newburyport, passes through the towns of Salisbury, Seabrook, Hampton Falls, Hampton, North Hampton, Greenland and Rye to Portsmouth.

The eastern line passes through the same towns, with the exception of Greenland, its course being generally from one half to two miles nearer to the sea coast. The length of the western line from the Merrimack river to

the Universalist meeting house, on Pleasant street, in Portsmouth, is 19 miles, 380 feet.

The length of the eastern line between the same points is 18 miles, 3448 feet; difference 2212 feet.

The length of the western line, from the Merrimac river to navigable water in Portsmouth is 19 miles, 1080 feet.

The length of the eastern line to navigable water in Portsmouth is 19 miles; difference 1080 feet.

The length of the western line in Massachusetts is 3 miles, 3090 feet, and in New Hampshire 15 miles, 2570 feet.

The length of the eastern line in Massachusetts is 3 miles, 1235 feet, and in New Hampshire 15 miles, 2213 feet.

17 miles, 1820 feet of the western line is straight.
1 " 3840 feet is curved on radii of 1 mile.
15 " 1288 feet of the eastern line is straight.
3 " 2160 feet is curved on radii of 2-3 of a mile.

The grades of the two lines, passing from the Merrimac river eastward, are as follows;

Of the western line.
4 miles, 5180 feet level.
7 " 1740 feet descending 30 to 15 feet per mile.
6 " 4020 feet ascending 15 to 35 " "

19 miles, 380 feet.

Of the eastern line.
5 miles, 4388 feet, level.
6 " 1120 feet, descending 30 to 20 feet per mile.
6 " 3220 feet, ascending 13 to 30 " "

18 miles, 3448 feet.

Estimate of grading, masonry and bridging, and cost of the same, on the western line.

*Section* 1. *Length* 9,300 *feet.*

| | | |
|---|---|---|
| 600 | running feet of frame structure at $3 per foot, | $1,800 |
| 1 | abutment of stone, | 400 |
| 42,400 | yards excavation (24,000 marsh,) 17 cts., | 6,784 |
| 500 | perches culvert masonry, | 750 |
| 1 | bridge and abutments, | 600 |
| | road and farm crossings, | 200 |

*Sec.* 2. *Length* 9,630 *feet.*

| | | |
|---|---|---|
| 18,700 | yards excavation, at 18 cts., | $3,366 |
| 1,300 | " rock " 1,00 | 1,300 |
| 700 | perches culvert masonry, | 1,050 |
| | road crossings, | 150 |
| | Total to the State line, | $16,400 |

*Sec.* 3. *Length,* 9,170 *feet.*

| | | |
|---|---|---|
| 37,000 | yards excavation, at 18 cts., | $6,660 |
| 300 | perches culvert masonry, | 450 |
| | bridge or culvert, Smith's pond, | 700 |
| | farm crossings, | 100 |

*Sec.* 4. *Length,* 9,900 *feet.*

| | |
|---|---|
| 38,000 yards excavation, [17,000 marsh,] 17 cts., | $6,460 |
| 500 yards rock excavation, at $1,00, | 500 |
| 700 perches culvert masonry, | 1,050 |
| road and farm crossings, | 250 |

*Sec.* 5. *Length,* 11,500 *feet.*

| | |
|---|---|
| 72,000 yards excavation [11,000 marsh] 22 cts., | $15,840 |
| 800 perches culvert masonry, | 1,200 |
| 1 road bridge, | 800 |
| road and farm crossings, | 400 |

*Sec.* 6. *Length* 9,700 *feet.*

| | |
|---|---|
| 38,500 yards excavation at 17 cts., | $6,545 |
| 400 perches culvert masonry, | 600 |
| 2 road bridges, | 1,600 |
| road crossings, | 200 |

*Sec.* 7. *Length,* 11,300 *feet.*

| | |
|---|---|
| 37,800 yards excavation at 17 cts., | $6,426 |
| 700 perches culvert masonry, | 1,050 |
| 1 road bridge, | 1,000 |
| road crossings, | 100 |

*Sec.* 8. *Length,* 9,400 *feet.*

| | |
|---|---|
| 23,000 yards excavation at 17 cts., | $3,910 |
| 1,000 yards rock excavation at $1,00, | 1,000 |
| 700 perches culvert masonry, | 1,050 |
| road crossings, | 250 |

*Sec.* 9. *Length,* 10,300 *feet.*

| | |
|---|---|
| 35,000 yards excavation, at 18 cts., | $6,300 |
| 1 000 rock excavation, at $1,00, | 1,000 |
| 800 perches culvert masonry, | 1,200 |
| 1 road and farm bridge, | 1,400 |
| road crossings, | 200 |

*Sec.* 10. *Length,* 10,500 *feet.*

| | |
|---|---|
| 28,000 yards excavation, at 18 cts., | $5,040 |
| 600 running feet bridging, at $6,00, | 3,600 |
| 2 abutment and bank walling, | 1,200 |
| 800 perches culvert masonry, | 1,200 |
| 2 road bridges and crossings, | 2,219 |
| Total from the State line, | $81,500 |

Estimate of grading, masonry and bridging, and cost of the same on the eastern line.

From the Merrimac river to the line of the State.

| | |
|---|---|
| 1,400 running feet of frame and pile structure at $3 per ft., | $4,200 |
| 1 abutment of stone, | 400 |
| 70,000 yards excavation at 18 cts., | 12,600 |
| 2,400 yards rock excavation at $1,00, | 2,400 |
| 1,050 perches culvert masonry, | 1,575 |
| road and farm crossings, | 350 |
| Total | $21,525 |

From the line of the State to Portsmouth.

| | | |
|---|---|---|
| 309,000 | yards excavation at 18 cts., | $55,620 |
| 13,100 | yards rock excavation at $1,00, | 13,100 |
| 4 | road bridges, | 3,200 |
| | road and farm crossings, | 1,500 |
| 1,625 | running feet of bridging at $6, | 9,750 |
| 14 | bridge abutments, | 3,500 |
| 3,850 | perches of culvert masonry, | 5,825 |
| 2 | draws and piers, | 5,000 |
| | Total, | $97,495 |

The aggregate cost of the whole road from the depot in Newburyport, by the western line to Portsmouth, is thus estimated.

| | |
|---|---|
| For grading, damages, &c., in Newburyport, | $8,000 |
| " bridge across Merrimac river, | 45,000 |
| " grading, masonry and bridging to the State line, | 16,400 |
| " 3 3-5 miles of railway or superstructure, at $8,500 per mile | 30,600 |
| " land, damages, and fencing, | 5,500 |
| " depot, | 500 |
| " engineer department and salaries, | 2,000 |
| Total to the line of the State, | $108,000 |
| For grading, masonry and bridging from State line to Portsmouth | $81, 500 |
| For 16 2-5 miles of railway at $8,500 | 139,400 |
| " land, damages, and fencing, | 31,000 |
| " depot buildings, and fixtures, | 10,100 |
| " engineer department and salaries, | 13,000 |
| Total from line of the State, | $275,000 |
| Total cost of the whole road, | $383,000 |

The aggregate cost, by the eastern line, is thus estimated:—

| | |
|---|---|
| For grading, damages &c., in Newburyport, | $8,000 |
| " bridge across Merrimac river, | 45,000 |
| " grading, masonry and bridging to the State line, | 21,525 |
| " 3 1-4 miles of railway at $8,500, | 27,625 |
| " land, damages, and fencing, | 5,000 |
| " depot, | 350 |
| " engineer department and salaries, | 2,000 |
| Total to the line of the State, | $109,500 |
| For grading, masonry, and bridging from State line to Portsmouth, | $67,495 |
| For 16 1-4 miles of railway at $8,500, | 138,125 |
| " land, damages, and fencing, | 28,780 |
| " depot buildings and fixtures, | 10,100 |
| " engineer department and salaries, | 13,000 |
| Total from line of the State, | $287,500 |
| Total cost of the whole road, | $397,000 |

The advantages possessed by the western line are,

1. That it runs more inland, and through a denser population than the eastern line, and moreover secures all the travel which the eastern line would have, indeed all the sea cost. It runs about two miles nearer than the eastern, to New Market and Greenland; the former being about seven,

the latter one and three-fourths miles from the western line; thus making the distance from Boston to New Market by the eastern railroad short of 57 miles.

2. The western route can very easily be continued to cross the Piscataqua river by a bridge, while by the eastern it is easier to cross that river by a ferry, a great objection to which, being loss of time. The facilities however for a ferry are very great—it would be short, direct, over smooth water, and not expensive to maintain.

I would remark here, that I have examined with much care, the facts connected with the construction of a bridge to cross the Piscataqua for the direct continuation of the railroad to the eastward, and I state with certainty that there will be no difficulty in constructing a very superior bridge across this river, safe and firm in every respect, and free from the objections connected with the present structure. I estimated with minuteness the cost of such a bridge, and found it, for one which would accommodate both the common and the railroad travel, less than $80,000, or less than $40,000 for the accommodation of each; it is well known that for the common travel this sum would be a very reasonable expenditure.

3. The western line is free from draws, while the eastern must have two or three.

4. The western line has the most straight line, and the least curved, and the curves are on the greatest radii.

5. The marsh embankments are very much more exposed on the eastern than on the western line, to the action of ice and the sea.

6. The western line has much less bridging than the eastern—this bridging is chiefly objectionable on account of decay and danger from fire.

The only advantage possessed by the eastern line, which I am aware of is that of distance—it being about half a mile shorter than the western, to the Universalist meeting house, and one-fifth of a mile shorter to navigable water. With regard to the differences of grades and expense, they are small —that of the grades being in favor of the eastern, and that of the expense of the western line.

The excavation on both routes will be in gravel and sand, coarse gravel and marsh chiefly—there being very little clay on either line. The quantity of rock excavation is unusually small on both routes—on the western but 4,000 yards and on the eastern about 15,000 yards.

The whole length of the railroad from Boston to the proposed depot in Portsmouth, by the western line, is 53 miles, 2390 feet; by the eastern line it is 53 miles, 178 feet. In connection with these distances, it may be proper to remark, that from examinations which I have made, the length of a railroad to Dover from Portsmouth, would be short of 10 miles; making the distance from Boston to Dover, should such a road be built, not exceeding 63 miles.

The grading, etc., of the road is so favorable, that the whole may be completed, and the road be made ready for travel, within a year from this time. As to the advantages which it will offer when built, and its prospects of success, they are too well known and too certain to require any detail. The certainty that it will be decidedly for the interest of the eastern steam boats to run from Portsmouth instead of Boston, by which they will escape entirely the unsafe and tedious part of their routes, is obvious; and the travel from and to them alone, though not a moiety of that which will pass over the road, will yield a large revenue to the stockholders.

I cannot close this report without stating, that much credit is due to HENRY WILDER, Esq., my assistant engineer, and those who composed

the party under him, for the faithfulness and perseverance manifested by them in making the surveys and plans for this report. The time allowed to them was very short, and they have performed the duty thoroughly and well.

Respectfully submitted,

JNO. M. FESSENDEN.

*Engineer eastern railroads in N. H. and Mass.*

SALEM, August 15. 1839.

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HARLEM RAILROAD.—*Celebration of the completion of the double track.*

This enterprizing company celebrated on the 3d inst., at Nowlan's pavilion the final completion of their great work. They have excavated, blasted and levelled formidable rocks—filled up deep ravines—constructed substantial bridges, and laid down substantial rails—with all these obstacles they have persevered through evil, and through good report—they have employed thousands of laborers and honorably paid them—at last they have reached the completion of their scheme, and have laid down a *double track* from the centre of the city, to the extent of their limits—Harlem river—at the expense of $1,100,000. It is undoubtedly the commencement of the *great work* of internal improvement, that is to connect this city with the great western lakes. It is to be the great artery that is to facilitate travel and trade at all seasons of the year, when the Hudson is bound in icy fetters, with the rich and prosperous towns and cities of the west.

The company invited was very numerous; consisting of the members of the court for the correction of errors—members of assembly and congress—members of the common council—chancellor Walworth—Judges Edwards, Jones, Oakley and Ingraham—Maj. Gen. M'Comb, Maj. Gen. Sandford, Brig. Gen. Morris—Ex-Mayors Bowne, Hone and Clark—Chevalier Gerstner, of Austria—besides a great number of our own most respectable citizens, and gentlemen of the press generally.

Samuel R. Brooks, Esq., president of the company, presided, assisted by William Paxon Hallet, Esq., and Ald. Greenfield, members of the board of directors.

The president, Mr. Brooks, made a most interesting statement of the progress and condition of the company, and the value and importance of similar works. He said in substance condensed:—

At this meeting to celebrate the completion of a double track of railway from the City Hall at the park to Harlem River, and which has been accomplished by individual enterprise, unaided by the funds of the State or the Nation, is an occasion in which men of all parties and shades of parties cannot fail to take deep interest.

However widely we may differ on other matters, here at least we can scarcely fail to be unanimous. On this day and on this occasion, all personal all political feelings are quelled; all strife of party is hushed: and we are incapable, I trust, said he, whatever our political opinions may be, of refusing to rejoice at the completion of a double track of railroad from the heart and center to the outer boundary of the great commercial capital of this great republic.

Although we have met to celebrate the successful works of the past, yet we must hope that it will tend to promote important results in relation to the works of the future, especially in giving a proper tone to public feelings,

and efficient patronage to the extension of this road, by the construction of the New York and Albany railroad.

In expressing this hope, I cannot, said Mr. B., but feel some degree of doubt as to its being realized, if we rely for the means of doing it on funds to be derived from England, by the sale of bonds of the State or company.

Our forefathers ',in the early settlement of the country, had no other mode of communication with each other than that of a foot or bridle path, and what was their course of action under such circumstances? Why, gentlemen, their public spirit and patriotism induced them to turn out individually and not only give the land, but give their daily labor to convert the foot path into a good country road. This was done throughout the whole extent of our country, and by one united effort of all classes and conditions of men they had good roads constructed.

What, gentlemen, is the present mode of action on the introduction of railroads? Why, we see in numerous instances, they rely on foreign funds for their construction. Surely the modern railroad is as great an improvement on the turnpike, as the common road was on that of a foot-path. Why is it then, that we of the present day do not find the same generous spirit of individual contributions, of associations relying on their own means, and as freely offering them for the construction of this greatest of modern improvements, as were our forefathers in their gifts of land labor and money?

Why is it, that such a projected road as the New York and Albany railroad is deprived of the means of construction? I fear the answer will be found in the fact, that the public rely upon the sale of bonds in Europe to supply the necessary funds.

From present appear ances I fear the progress of events are not likely to restore or create confidence sufficient to afford our agents abroad the power of negotiating our securities at satisfactory prices. Hence the necessity of those who reside on the line of that wealthy tier of counties through which the New York and Albany railroad is projected, knowing and feeling, that if they expect the road to be constructed, they must rely upon their own means and ample resources for its successful completion.

The New York and Harlem railroad has been completed from the city hall to Harlem river by individual enterprise, unaided by the bonds of the State or the Nation, and so can the Albany railroad be constructed. But if the public rely upon the sale of bonds in foreign markets for the necessary funds to construct the road, I fear they will rely upon that, which will prove but a broken reed.

Gentlemen, I ought to apologise for the time I have claimed your attention to these remarks, but hoping that they may prove useful in the real promotion of internal improvement, I forbear to detain you longer, and will proceed to announce to you the first regular toast which the committee of the board have prepared for the occasion.

After these remarks the president announced the regular tosts, which we omit, and add a few of the volunteers.

By the president.—*The New York and Albany railroad.* May it soon reach the St. Lawrence in the east, lake Erie in the west, Canada in the north, and the Mississippi in the south. Four cheers.

Charles Henry Hall, Esq., president of the road replied.

[We hope to present Mr. Hall's reply in our next number.—*Eds. Jour.*]

By Wm. Paxton Hallet, Esq.,—*The Empire State*—Interlaced with veins of iron, who shall put a limit to the development of her gigantic resourses?

By John V. Greenfield, 2nd vice presdent.—*The United States*—Linked together, not only by the ties of political friendship, but by bands of iron —May both ties and bands be equally indissoluble.

By Philip Hone.—*The Locomotive*—The only good motive for riding a man upon a rail.

By Thomas Sargent.—*Dr. Darwin and his prophecy*—Half a century before the accomplishment of the prediction, he wrote these lines:

> "Soon shall thy power, unconquered steam! afar
> Drag the swift barge, and speed the ponderous car."

By Jos. E. Bloomfield.—*Railroads*—The great desideratum—to bind the Union in an iron band of brothers. An improvement of the age, as important and necessary to connect all parts of the Union with their commercial centre, New York,—as steam packets furnish the facilities to unite us to England and the world.

By Isaac Gibson.—*Railroads throughout the world*—They have brought the great family of mankind into nearer and more genial communion—they have levelled old prejudices—created new affinities—and given a new impetus to the great cause of civilization. May their extent be unlimited.

By James R. Whiting.—*The memory of Robert Fulton.*—The smoke which our transatlantic steam ships leave behind them on the great deep, forms a wreathe for his fame prouder tha nthe laurels of theconqueror.

By Edwin Post,—*Our locomotive steam engines*—Who would transfer to acheing human shoulders the burthens so easily borne by those "patient metallic laborers."

By Silas M. Stilwell.—*The travelling community*—Their increase is in proportion to the increase of facilities for locomotion, and the more numerous they are, the more numerous will be the friends of the Union.

By Heman W. Childs.—*Evans, Perkins and Watt*—To their improvements and inventions we owe the availability of the steam engine for our railroads—may the obligation be ever gratefully remembered.

By Mr. M'Elrath.—*The New York and Harlem railroad*—Uniting the extremes of the city of New York into one common ward; equalizing property over the whole island; affording healthful abodes to the industrious and frugal, in place of miserable habitations in the narrow and impure streets of the lower wards. It is at once the poor man's carriage and the working man's hackney coach.

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Electro-Magnetic Navigation.—Mr. Faraday recently received a letter from M. H. Jacobi, dated St. Petersburgh, on the application of electro-magnetism to navigation; Mr. Faraday has caused it to be inserted in the *London and Edinburgh Philosophical Magazine* for the current month. The following is a short extract from this curious paper:—"In the application of electro-magnetism to the movement of machines, the most important obstacle always has been the embarassment and difficult manipulation of the battery. This obstacle exists no longer. During the autumn of 1838, and at a season [in 1839] already too advanced, I made as you will have learned by the *Gazettes*, the first experiments in navigation on the Neva, with a ten-oared shallop, furnished with paddle wheels, which were put in motion by an electro-magnetic machine. Although we voyaged during entire days, and usualy with ten or twelve persons on board, I was not well satisfied with this first trial, for there were so many faults of construction, and want of insulation in the machines and battery, which could not be repaired on the spot, that I was terribly annoyed. All those repairs and important changes being accomplished, the experimenents will shortly be recommenced. The experience of the past year, combined with the recent improvements of the battery, give us the result, that to produce the force of one horse (steam engine estimation,) it will require a battery of 20 square feet of platina distributed in a convenient manner, but I

hope that eight to ten square feet will produce the effect. If Heaven preserves my health, which is a little effected by continual labor, I hope by next midsummer I shall have equiped an electro-magnectic vessel of from 40 to 50 horse-power!"—*Eng. Paper.*

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Table of the Mean Temperature of the years 1833, 1834, 1835, 1836, 1837, and 1838; the extreme coldest and hotest day in each year; and the number of days that was clear, cloudy, rainy, white frost, foggy morning, snow, hail or sleet.

| Years. | Mean temp. of each year | | | | Thermometer, the extreme in each year. | | | | Number of days in each year, that was either | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morn. | Noon | Night | of the Year. | Date. | low'st | Date. | high't | Clear | Cl'dy | Rainy | White Frost | foggy Morn. | Snow | hail or Sleet. |
| 1833 | 60 | 73 | 68 | 67 | Nov. 26th | 25 | July 29th | 93 | 230 | 135 | 72 | 22 | 7 | | |
| 1834 | 60 | 73 | 67 | 67 | Jan. 5 | 16 | Aug. 20 | 92 | 202 | 163 | 101 | 19 | 18 | 3 | 3 |
| 1835 | 58 | 71 | 67 | 65 | Feb. 8 | 12 | July 29 | 89 | 221 | 144 | 93 | 25 | 14 | 2 | 2 |
| 1836 | 59 | 72 | 65 | 65 | Dec. 21 | 19 | July 23 | 93 | 229 | 137 | 84 | 36 | 5 | | 1 |
| 1837 | 59 | 71 | 67 | 66 | Jan. 15 | 24 | June 2 | 91 | 229 | 136 | 71 | 27 | 16 | 1 | 1 |
| 1838 | 59 | 70 | 65 | 66 | Feb. 16 | 12 | June 25 | 94 | 248 | 117 | 72 | 35 | 7 | | 3 |
| Aver. six years. | 59 | 72 | 67 | 66 | | | | | 226 | 139 | 82 | 27 | 11 | 1 | 2 |

Table of the *average* of the Mean Temperature, taking each of the months together, for the years of 1833, '34, '35, '36, '37, and '38; also, the average of the number of days for each of the months of the six years, that was clear, cloudy, rainy, white frost, foggy morning, snow, hail or sleet.

| | Aver. mean temp. for six years. | | | | Average of each month for six years together. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Morn. | Noon | Night | M'nth | Clear | Cl'dy | Rainy | White Frost | foggy Morn. | Snow | hail or Sleet. | Remarks. |
| January, | 45 | 57 | 53 | 52 | 16 | 15 | 9 | 4 | 1 | 1 | 1 | |
| February, | 44 | 58 | 54 | 52 | 15 | 13 | 6 | 6 | 1 | | 1 | |
| March, | 52 | 65 | 60 | 59 | 16 | 15 | 7 | 3 | | | | |
| April, | 60 | 73 | 67 | 67 | 19 | 11 | 7 | | 1 | | | |
| May, | 66 | 78 | 73 | 72 | 20 | 11 | 8 | | | | | |
| June, | 73 | 85 | 80 | 79 | 23 | 7 | 5 | | 1 | | | |
| July, | 74 | 86 | 80 | 80 | 21 | 10 | 9 | | 1 | | | |
| August, | 73 | 86 | 81 | 80 | 20 | 11 | 7 | | 1 | | | |
| September, | 68 | 81 | 75 | 75 | 18 | 12 | 8 | | | | | |
| October, | 58 | 71 | 66 | 66 | 21 | 10 | 5 | 1 | 1 | | | |
| November, | 48 | 62 | 59 | 56 | 21 | 9 | 5 | 5 | 2 | | | |
| December, | 44 | 57 | 53 | 51 | 16 | 15 | 5 | 8 | 2 | | | |
| Aver. a year. | 59 | 72 | 67 | 66 | 226 | 139 | 81 | 27 | 11 | 1 | 2 | |

Oswego and Syracuse Railroad.—A scientific examination of the route for a railroad from this village to Syracuse, is now in progress by an engineers corps, under the direction of Mr. C. B. Stuart, who was the able and efficient resident engineer on the Utica and Syracuse railroad from its commencement to its completion. The engineers will examine several routes, and report in relation to such as appear feasible. They have now been one week engaged in the survey, and we learn that the ground thus far is considered favorable. The result of these examinations, it is expected, will be given to the public before the opening of the books for subscriptions to the stock of the company in October next. From the reputation of the engineers engaged, and the success which has attended their labors on the Utica and Syracuse railroad, the public will have a guarantee that their report can be relied upon with the utmost confidence.—*Oswego Pal.*

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

No. 8. Vol. III. New Series. | OCTOBER 15, 1839. | Whole No. 344. Vol. IX.

*Errata.*—Article, 'Right of way for Railroads, etc.,' page 196, 27th line, for "men," read *mere*. Page 197, 11th line, for 'Premier,' read *Province*. Same page, 21st line, for 'chamelion of corporation,' read *chamelion corporation*.

## ERIE CANAL ENLARGEMENT UNNECESSARY,

*From the decrease of tonnage derived from the forrest.—Railroads destined to change transportation from and to the sea board.*

Messrs. Editors:—It is now near five years since your valuable Journal admitted articles endeavoring to show the folly of this splendid piece of extravagance. The controversey of the State engineers with Mr. E. F. Johnson, who early took ground against their plan, to secure the western trade and *cheap transportation*, was admitted in your Journal in 1835, and a free discussion solicited, whilst other papers refused to investigate the subject.

Writers in your Journal, and the Times, of this city, questioned the truth of the estimate of $12,400,000, then made for the enlargement—the feasibility of doing it, within any reasonable time, and not intercept navigation on it—or at an expense that would be submitted to by the people. The advocates for the canal arround Niagara falls, and the improvement of *natural waters* from Oswego by lake Oneida, and the north side of the Mohawk river to the Hudson, [to provoke competition] and who warned the public that the estimates were deceptive, were ridiculed. That the estimate of the last winter, $23,400,000, which does not include damages and loss of interest during the construction, and is only an approximation to the truth, we are led to conclude, when we find that the State engineers, in 1835, estimated the cost of the Rochester Aqueduct of stone, at $141,074—when the actual cost will exceed $600,000. A wooden trunk to cost $30,000, would have been as durable as those they propose to build over the Mohawk. It is these estimates and useless expenditures, attended with the fact that the tonnage derived from the forrest, decreases faster than it is supplied by agriculture and manufactures, that has settled the question as to the propriety and necessity of the enlargement, to the injury of the State credit, and to the

prostration of other necessary works. Half the expenditure required for the Erie canal, to enlarge it, [with the destruction of the original work, which should be estimated in the cost of the *new canal,*] will complete every important line of railway in the State of New York.

If $30,000,000 *must* be expended, on the canal, to be a monument of our folly, [since the improvements in railroads, and the locomotive engine,] to procure only seven months, average trade by water, with the west, it is evident that other state works must stop for want of funds. It is equally certain, that if we expend thirty millions of dollars on the Erie canal, and eight millions on the Genessee valley and Black river canals, there will be no credit left to the State to even 'aid,' and certainly no funds to construct railways, by the State, as advocated by many. With this view of the subject, which we honestly believe to be correct, shall we be deprived of railroads, for intercourse with the interior, at all seasons of the year, and neglect a necessary class of improvements, to compete with our neighbors. A railroad from Albany to Buffalo will entirely relieve the Erie canal, of the semi-packet or line boats, that now takes up half the capacity of the Erie canal, with their lockages, and who do not carry on an average one-third of a load, yet with even this class of boats, that the railroad will soon drive from the canal, it is ascertained by official reports, that the down tonnage has decreased since 1835, and it is well known, that the up tonnage is only in the ratio of one to five for the down, and no enlargement will ever be required for the up tonnage, whilst railroads will greatly, if not entirely relieve the Erie canal from the down tonnage from the west.

"The enlargement," it has been shown, is not now required, and if persisted in, will defeat its great object, *cheap transportation.* This must occur from the rate of toll required to pay the interest on its cost, which we repeat *will exceed* thirty millions of dollars.

This is not all. The last winter's attempt to excavate frozen earth, ice and snow, between Albany and the Cohoes falls, and at Utica, has satisfied all those who have viewed it, that public opinion will not sustain this extravagant expenditure to the exclusion of aid and State patronage to railroads, on lines and sections of the country where canals cannot be constructed.

If we are to believe the report made last winter by a select joint committee of both branches of the legislature of Massachusetts composed of intelligent and practical men, who duly investigated the subject of railways, for transportation, as well as for passengers, this class of improvement in our northern climate, is superior to canals, inasmuch as the capacity of a well constructed and located railway, is considered superior to the Erie canal, celerity of motion, and use at all seasons of the year being considered. ☞ Railroads are destined, and must change the course of business and transportation, from the sea board.

It is gratifying to find that Mr. Edwards presents the view in your Journal of September, that the Philadelphia and Reading railroad can success-

fully compete with the Schuylkill canal, the best located for a profitable business in the United States, from its descending trade in coal. It has for several years yielded its original stockholders from 20 to 25 per cent per annum; and the stock has stood as high as $350 for 100 paid. Such now is public opinion in Pennsylvania; from their experience of the capacity of a well constructed railway to transport coal and merchandize, that even prior to the present pressure in the money market [the Schuylkill canal, runs side by side with the Philadelphia and Reading railroad,] that the canal stock has fallen from 350 to 170 per cent, in view of the competition that must take place. The importance of railroads for *general transportation*, entertained by Massachusetts, Pennsylvania and other States, should cause the next legislature of this State to examine into their merits. If this is done, we venture to predict, that the State report of 1835, comparing canals and railroads, adverse to the latter, will receive numerous corrections, by the facts in support of railroads now before the public derived from actual experience in this country and in Europe, since 1835.

ONTARIO.

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EXTRACTS FROM THE REPORT OF TRANSACTIONS OF THE INSTITUTION OF CIVIL ENGINEERS.—March 5, 1839.

The President in the chair—"On the comparison between the power of locomotive engines and the effect produced by that power at different Velocities." By Professor Barlow, Hon. M. Inst. C. E.

In this communication the author attempts to lay down an appropriate method for computing the power of locomotive engines; and though this method will not serve to exhibit the absolute power of the engines, it may serve to exhibit the comparative power under different conditions.—We know the number of cubic feet of water evaporated in any given time; the space passed over in that time; the diameter of the driving wheels; the length of stroke, and the capacity of the cylinder; we hence know how many cubic feet of steam have been employed, and consequently the mean number of cubic feet of steam produced from one cubic foot of water. Again, by experiments that have been made by different writers upon the elastic force of steam, we know the pressure per inch on the piston, and then making due allowance for the resistance of the atmosphere on the piston, the friction of the engine gear, etc., there remains the force that ought to be effective on the piston. This being reduced to the circumference of the wheel, should be equal to the resistance opposed by the load, which on a level plane consists of axle friction, road resistance, and the resistance of the atmosphere to the engine and carriages. But this is assuming that the engine has a perfect action, without any waste, which, however much to be desired, can never be the case in practice. Thus comparing what ought to be done in overcoming resistance with what is done, we shall learn the amount of power wastefully expended.

The author then selects some experiments from those made on the North Star and Harvey Combe engines, as reported by Mr. Wood to the directors of the great werstern railway. and illustrates by these the proposed method and exhibits the results in tables.

From one of these experiments, it appears that the steam power expended per ton of the gross load amounts to 32 pounds, whereas on a tolerably level line it is generally assumed that the retardation of such a load does not amount to more than nine pounds per ton; so that there appears to have

been a power expended more than three times as great as the mechanical resistance to which it was opposed, according to views hitherto taken on the subject.

The author then proceeds to consider the resistance to railway trains at different speeds, and these resistances he refers to, 1st, that of the atmosphere. 2nd, the friction of the axles. 3d, the road resistance. He discusses several experiments made by Mr. Wood, and remarks on the great discrepancies which they present—the atmospheric resistance in one case amounting to 353 pounds, and in another to 99·7 pounds at the same velocity, viz., $32\frac{1}{4}$ miles per hour; the friction in the former case being five or six pounds, and in the latter twenty pounds per ton. The results of the best experiments on the atmospheric resistance and on friction show that the former must be considered to vary nearly as the square of the velocity, and the latter to be constant, or independent of the velocity; but this law of the constancy of friction, owing to the peculiar circumstances of the case, cannot hold with respect to to the axles of railway trains.

Very much must be attributed to the increase of the road resistance as due to the deflection of the rails at high velocities, and to the state of oscillation to which all the parts of the carriages are subject, and the imperfection of the joints. The author proceeds to make some observations on the actual state of our knowledge with respect to the atmospheric resistance, and the effect of inclined planes on the working of a line of railway. The speed in descending planes is limited by considerations of safety, and in planes of 1-96, 1-100 and 1-220, it is not safe to descend with heavy loads at a greater mean rate than is attainable with the same load on a level;—that on planes between 1-750 and a level the whole attainable speed is admissible.

The method of inferring the power of an engine from the quantity of water evaporated was objected to on the grounds that so much water is lost by priming.

With respect to the resistance due to the imperfection of the joints, it was remarked that engineers are generally so much restricted as to the expense of making the joints of rails, they cannot adopt that which is the best; and it is a question well worthy of attention, whether the best kind of joint is not the most economical, as the wear and tear would be diminished, and the comfort of the passengers increased, by attention to this point.

The experience of the Dublin and Kingstown railway showed that great advantages would result from a better kind of joint being used. This railway, though so short and only having been finished about three years, has had perhaps more frequent traversings than a longer railway would in fifteen years; the trains started every half hour, and frequently the departures were increased to every quarter of an hour: the opportunities of observing the effect of the carriages upon the rails were therefore excellent.

March 12, 1839.—The President in the chair.—"Description of the machinery and the several processes for converting refined metal into malleable finished iron at the Rhymney works." By Josiah Richards, Assoc. Inst. C. E.

In this paper the author explains and describes the elaborate drawing of puddling furnaces, forge and rolling mills, at the Bhymney iron works, presented by him last session to the institution, and the various processes necessary for converting refined metal into finished malleable iron. Each puddling furnace usually receives as a charge $4\frac{1}{2}$ cwt. of refined metal, which is worked by the puddlers into six puddle balls in about an hour and a half. There are three sets of puddlers to each furnace, who relieve

each other every five charges. The puddled balls are drawn on wheeled trucks either to the hammer, weighing about 4½ tons, with a fall of 20 inches, where each receives about twenty-five blows, or to the squeezer; but this latter method does not get rid of the impurities so effectually as the former. The ball is then passed through a continually decreasing series of grooves in rollers, whereby it becomes puddled, or No. 1, bar. The bar is then cut into short lengths, allowed to cool, and made into piles of a particular weight and size, according to the description of the iron that is to be rolled; these being placed in a furnace are brought to a welding heat, and then passed through rolls and reduced to the requisite size, when they become No. 2, bar. The same operation of cutting, filing, heating, and rolling, being again gone through, the iron becomes No. 3, bar, or railway iron. No. 3 iron may be made from a pile, of which the top and bottom are of No. 2 iron and the middle of No. 1. It is then brought to a welding heat, and hammerd so as to be soundly welded; being again heated, it is rolled into No. 3, or railway iron.

The rail is received from the rolls on a carriage, and carried to a circular saw, where one end is cut off; the rail is then allowed to cool, and afterwards the other end is heated, and the rail cut to the required length.

March 19, 1839.—The President in the chair.—On Mr. Smeaton's "Estimate of animal power, extracted from his MS. papers." By John Farey, M. Inst. C. E.

The amount of mechanical power has been frequently overstated, in consequence of the conclusions being drawn from efforts continued for too short a time. Desaguliers estimated the power of a man as equal to raising 5507 pounds one foot high per minute: this was found by Smeaton to be too high; several experiments are recorded, in which different values are assigned to the power of a man, and he ultimately fixed it at about two-thirds of the above, or 3672 pounds. Several experiments are recorded of the estimate of the power of a horse and of the quantity of water raised by various machines.

The communication is accompanied by a letter in Mr. Smeaton's hand writing, dated 21st Feb., 1789.

"Account of the firing of gunpowder under water, by the voltaic battery at Chatham, March 16, 1839, under the direction of Col. Pasley." By F. Bramah, Jr., A. Inst. C. E., and C. Manby, A. Inst. C. E.

Exp. 1.—A tin canister containing 45 pounds of powder was sunk in deep water, and the coil containing the conducting wires one-fifth of an inch in diameter, by which the powder was to be fired, was veered out to its whole length of 500 feet from the boat in which the voltaic battery was placed. The connection being made, the explosion was instantaneous, and the concussion was felt very sensibly on the shore.

Exp. 2.—Three canisters, each containing a charge of five pounds, were sunk at a distance of 50 or 60 feet from each other, and a pair of connecting wires, 100 feet long, were attached to each; the ends of these wires were soldered together by threes, and on the connection being made only one of the canisters was fired. The wires in this experiment were of common copper bell wire, about one-sixteenth of an inch in diameter. The voltaic battery used, was one of Professor Daniell's improved construction. The preparation of the conducting wires, and the manner of discharging the battery, appeared the same as described in Mr. Bethell's communication of last session.

"Description of a machine called a Floating Clough."—By George Ellis, Grad. Inst. C. E.

The machine here described is used for scouring a channel which leads from the Winestead drainage and Haven of Pattrington, in the river Humber. It is constructed in the following manner:—The frame is made of timbers 6 inches by 4, 12 feet long, 9 wide, and 6 deep. This frame is covered with planking 2 inches thick, and through the middle of it a culvert is formed with planks, 2 feet 6 inches in width, with a small lifting door at one end. Connected with the bottom, and projecting in front, are two long beams called feelers, which keep the machine in its course, and in the front are frames of wood shod with rough iron like the teeth of a saw, and these are connected with racks which can be raise by a lever.

At each side of the machine there is a wing which is made to fit the slope of the banks, to dress the mud from the sides, and to keep up the water behind the machine.

At high tide the machine is moored in the middle of the channel, the wings are extended and kept so by ropes and when the tide is at half ebb the plugs are taken out, and the water rises about two feet in the machine, which causes it to sink; the plugs are replaced, and thus it remains till full ebb, when the iron-shod frames are let down in front, and the tide forces the whole machine, which is like a great dam, gently down the stream, scraping with it all the mud down to the river, where it is emptied, and floated back with the return tide. The whole distance, about three miles, is performed in two hours. A machine of the same kind is used with great advantage at Great Grimsby.

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ON THE METHOD OF PRODUCING COPIES OF ENGRAVED COPPER-PLATES, BY VOLTAIC ACTION; ON THE SUPPLY OF MIXED GASSES FOR DRUMMOND'S LIGHT, BY ELECTROLYSIS; ON THE APPLICATION OF ELECTRO-MAGNETISM AS A MOTIVE POWER IN NAVIGATION, AND ON ELECTRO-MAGNETIC CURRENTS. BY DR. M. H. JACOBI: IN A LETTER TO MR. FARADAY.

It is some time since, that during my electro-magnetic labors, a fortunate accident conducted me to the discovery that we might by voltaic action make copies in relief of an engraved copper-plate, and that a new inverted copy of those in relief might be obtained by the same process, so that the power was obtained of multiplying the copper copies to any extent. By this voltaic process the most delicate and even microscopic lines are reproduced, and the copies are so identical with the original that the most rigorous examination cannot find the least difference. I send you in the accompanying packet two specimens of such plates, which I hope you will accept with kindness. The one which is in relief is the copy of an original engraved with the burin; the second is the copy of that in reilef, and consequently identical with the original. The third is the original plate, but covered with reduced copper. I had the intention of making a second copy, but unfortunately the plates adhere so strongly at times that it is impossible to separate them. I cannot tell the cause of this intimate union which occasionally occurs, but it appears to be the case only when the copper at the surface of which the reduction is effected is brittle, and consequently is lamellar and porous. I may dispense with describing more at large the apparatus that I make use of. It is simply a voltaic pair *a cloison* where the engraved plate is used in the place of the ordinary copper plate, being plunged in the solution of sulphate of copper. I have found it necessary that a galvanometer with short wires should always make part of the cir-

cuit, so that one may judge of the force of the current and direct the action; the latter being effected by separating the electro-motive plates more or less from each other or modifying the length of the conjunctive wire, or finally, diminishing, more or less, the conducting power of the liquid on the zinc side; but for the success of the operation it is of great importance that the solution of copper should be always perfectly saturated. The action should not be too rapid: from 50 to 60 grains of copper should be reduced on each square inch in 24 hours. The accompanying plates have been formed, one in two days the other in one day only, and that is the reason why their state of aggregation is not so solid and compact as that of the small piece, No. 4, which has been reduced more slowly.

It is to be understood that we may reduce the sulphate of copper by making the current of a single voltaic pair pass through the solution by copper electrodes; as the anode is oxidized the cathode becomes covered with reduced copper, and the supply of concentrated solution may then be dispensed with. According to theory one might expect that exactly the same quantity of copper oxidized on one side would be reduced on the other, but I have always found a difference more or less great, so that the anode loses more than the cathode gains. The difference appears to be nearly constant, for it does not augment after a certain time, if the experiment be prolonged. A thoroughly concentrated solution of sulphate of copper is not decomposable by electrodes of the same metal, even on employing a battery of three or four pairs of plates. The needle is certainly strongly affected as soon as the circuit is completed, but the deviation visibly diminishes and very soon returns almost to zero. If the solution be diluted with water to which a few drops of sulphuric acid have been added, the current becomes very strong and constant, the decomposition goes on very regularly, and the engraved cathode becomes covered with copper of a fine pink red color. If we replace the solution of sulphate of copper by pure water acidulated with sulphuric acid, there is a strong decomposition of water even on employing a single voltaic couple. The anode is oxidized, and hydrogen is disengaged at the cathode. At the commencement the reduction of copper does not take place; it begins as soon as the liquid acquires a blue color, but its state of aggregation is always incoherent. I have continued this experiment for three days, until the anode was nearly dissolved; the color of the liquid became continually deeper, but the disengagement of hydrogen, though it diminished in quantity, did not cease. I think we may conclude from this experiment that in secondary voltaic actions there is neither that simultaneity of effect, nor that necessity of entering into combination or of being disengaged from it, which has place in primary electrolytic actions.

During my experiments many anomalies respecting these secondary actions have presented themselves which it would be too embarrassing to describe here: in fact there is here a void which it will be difficult to fill, because molecular forces which as yet we know nothing of appear to play a most important part.

With respect to the technical importance of these voltaic copies, I would observe that we may use the engraved cathode, not only of metals more negative than copper, but likewise of positive metals and their alloys, [excepting brass,] notwithstanding that these metals, etc., decompose the salts of copper with too much energy when alone. Thus one may make, for example, stereotypes in copper which may be multiplied as much as we please. I shall shortly have the honor to send you a bas-relief in copper, of which the original is formed of a plastic substance, which adapts itself to all the wants and caprices of art. By this process, all those delicate touches are preserved which make the principal beauty of such a work, and which

are usually sacrificed in the process of casting, a process which is not capable of reproducing them in all their purity. Artists should be very grateful to galvanism for having opened this new road to them.

During the last winter I frequently illuminated my saloon, which is of considerable size, by Drummond's light. The mixed gasses were obtained in sufficient quantities, that is to say, at the rate of 3 or 4 cubic feet per hour, by decomposing dilute sulphuric acid [specific gravity 1·33,] between electrodes of platina by a constant battery of a particular construction. I only passed the gas through a glass tube filled with chloride of calcium, and there was neither gasometer nor any other provision for it. As soon as the voltaic current was closed the jet might be lighted, and the flame then burnt tranquilly, and of the same intensity for any length of time. The construction and manipulation of the battery, though extremely perfect, was still a little embarrassing. At present, a battery, with a decomposing apparatus which will produce from 3 to 4 cubic feet of electrolyzed gas per hour, occupies little more space than the page of paper on which I write to you [10 inches by 8 inches] and is about 9 inches in height. Behold certainly a beautiful application of the voltaic battery.

In the application of electro-magnetism to the movement of machines, the most important obstacle always has been the embarassment and difficult manipulation of the battery. This obstacle exists no longer. During the past autumn and at a season already too advanced, I made as you may perhaps have learned by the *Gazettes*, the first experiments in navigation on the Neva, with a ten-oared shallop, furnished with paddle wheels, which were put in motion by an electro-magnetic machine. Although we voyaged during entire days, and usualy with ten or twelve persons on board, I was not well satisfied with this first trial, for there were so many faults of construction, and want of insulation in the machines and battery, which could not be repaired on the spot, that I was terribly annoyed. All those repairs and important changes being accomplished, the experimenents will shortly be recommenced. The experience of the past year, combined with the recent improvements of the battery, give as the result, that to produce the force of one horse (steam engine estimation,) it will require a battery of 20 square feet of platina distributed in a convenient manner, but I hope that eight to ten square feet will produce the effect. If Heaven preserves my health, which is a little effected by continual labor, I hope by next midsummer I shall have equiped an electro-magnectic vessel of from 40 to 50 horse-power.

In my paper, "On the application, etc.," I have spoken of the influence which those magneto-electric currents which you had discovered a short time before, would exert on the progress of electro-magnetic machines. They are properly the cause that the expectations which have been entertained regarding these machines have not as yet been fulfilled. But if one examines them more nearly these currents are not so disadvantageous as have been supposed. Experiments which I have made by interposing a galvanometer or a voltameter have taught me that during the action of the machine the electrolytic action of the battery is much less, and sometimes not more than half that which takes place when the machine is stopped, the current still passing by the helices which surround the bars of iron. Thus if on the one part the magneto-electric currents diminish the force of the machine, on the other the electrolytic dissolution of zinc, which makes the greatest part of the current expense, is at the same time considerably diminished. I have not as yet succeeded in completely developing the mutual relations of the current before and during the working of the machine.

I take the liberty of sending you some memoirs from the *Buletin scientifique* of the Academy. The result of the joint memoir of myself and M. Lenz is *that the attraction of electro-magnets is as the square of the force of the current, or as the square of the electrolytic action of the battery.* It appears that this important law holds good for machines in motion; at least the experiments I have made on that point do not depart from it more than may be admitted as the error of observation or the result of accidental circumstances.

I am, &c.

St. Petersburg, June 21, 1839. M. H. Jacobi.

*London and Edinburg Phil. Mag. for September.*

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ERIE CANAL.

*Tonnage passing, and lockages at Alexander's Lock No.* 26, *three miles west of Schenectady.—Two tests, that the "more speedy enlargement" is entirely unnecessary.*

*First test.*—The lockages at the most glutted point, Alexander's lock, will test the capacity of the Erie canal. If there were no locks on the Erie canal, its capacity would be illimitable. The locks make the delay, and the number of boats, the lock at the most glutted point will pass, is the test of the capacity of the canal. If the lockages increase at that point, the necessity of the enlargement increases; if the lockage diminish at that point, the necessity of an enlargement diminishes.

The following are the lockages at that point in the last four years.

| | | | |
|---|---|---|---|
| 1835 | to September 1, | 14,981 | lockages. |
| 1836 | " | 15,324 | " |
| 1837 | " | 10,711 | " |
| 1838 | " | 13,598 | " |

*Second test.*—The tons of moving matter, whether in boats or rafts, delivered at *tide water*, and the composition of such matter. This, while it furnishes another test, discloses the *reason why* the necessity of an enlargement of the canal, at the most glutted point diminishes.

In senate doc. No. 27 of 1839, statement No. 6, will be found a statement of the tons of property which reached tide water in each of the years from 1835 to 1838 inclusive, as follows:

| | 1835. *Tons.* | 1836. *Tons.* | 1837. *Tons.* | 1838. *Tons.* |
|---|---|---|---|---|
| The forest | 540,202 | 473,668 | 385,017 | 400,877 |
| Agriculture | 170,954 | 173,000 | 151,469 | 182,142 |
| Manufactures | 8,849 | 12,906 | 10,124 | 8,487 |
| Other articles | 33,187 | 36,773 | 65,171 | 48,975 |
| Total tons | 753,191 | 696,347 | 611,781 | 640,481 |

Now this is what comes to the Hudson river over that part of the canal which does the most business. Let the reader examine the matter of which this down tonnage is composed. Two-thirds, or 66 out of 100 tons, is from the forest; from trees, boards, plank, etc. The most of the residue, is from agriculture—from the tillage of the earth, wheat, rye, corn, etc., and

from grazing—beef, pork, butter, cheese, etc. The decrease of the forest is 139,325 tons, The total decrease in four years, is 112,690 tons—equal to 15 per cent.

Now let the intelligent reader reflect. Will the forest, the trees, increase, *or* will they not rather continue to decrease faster than agriculture increases? Will not what has been, continue to be? If it will, then is the "enlargement," with *double* locks on the *whole line* unnecessary and unwise. If it is, even the doubling of the locks will not be necessary until by the diminution of the forest, and the increase of agriculture, the lockage at Alexander's lock shall exceed the lockages of 1836. ☞ The new double locks are equal to eight times the capacity of the present single locks.

The above views are taken from a writer in the Argus, and completely proves the position taken in this number, by

ONTARIO.

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SPECIFICATION OF A PATENT FOR MANUFACTURING SUGAR FROM BEETS. GRANTED TO JOSEPH HURD, JR., OF THE CITY OF BOSTON, JULY 26TH, 1838.

To all whom it may concern: Be it known, that I, Joseph Hurd, Jr., of Boston, in the State of Massachusetts, have invented an improved mode of manufacturing sugar from beets, by which the process is so much facilitated as to enable every cultivator to perform it in his own family, with great economy and efficiency; the apparatus employed not being costly in the first instance, and the opperation being carried on, principally by means of such utensils as every farmer already possesses.

The beets, after being taken from the ground, and freed from all extraneous matter, are to be cut into slices the thickness of which should not much exceed the eighth of an inch. I have invented a machine for the purpose of performing this operation, which is more effective than any other with which I am acquainted, and for which I have obtained letters patent of the United States. The beets are to be taken out of the ground as soon as they are perfectly matured, and are then to be stored in a cellar, or other suitable place, as otherwise they rapidly undergo a change unfavorable to the production of sugar; they are to remain in this situation until the arrival of the time for slicing and drying them. The proper period for this opperation is the earliest season of frost; as in my process, they are to be exposed to a freezing temperature, so as to freeze and dry them in the air immediately after they are cut. This freezing is an essential point in my process; this, together with the dispensing with the use of lime, and the producing of sugar without molasses, may be denominated its characteristic features. To dry the beets after slicing them, they may be spread out upon laths, or upon netting, or in any other manner in which they will be most completely exposed to the frost, and to the wind; the desiccation, when sliced as above directed, requires but a short space of time, and is effected without injury to the saccharine principle. After being thus frozen and dried, the subsequent steps of the process may be performed at any time, as not the slighest injury will result from keeping the beets in a dry state for any length of time.

When it is desired to proceed to obtain the sugar from the beets immediately, they may be subjected to the freezing process only, then thawed and

submitted to pressure; they will then readily yield the greater part of their juice, which they would not have done if pressed prior to their being frozen. The pressed slices, with the residuum of the sugar contained in them may afterwards be dried, and kept as food for cattle.

When the sugar is to be extracted from the dried beets, which may be done at any season, they are to be steeped in pure water, which will take up all the soluble matter, an effect consequent upon the change produced in the beet by freezing. The quantity of water need only be such as shall suffice to cover the beets, and may be about one-half of that which was lost in the process of drying. The soluble materials consist principally of the sugar, the mucilage, and a portion of coloring matter. To free the sugar from the mucilage and coloring matter, I generally acidulate the water before pouring it upon the dried beets, by adding to it a minute portion of sulphuric acid; the quantity of this cannot be easily designated, otherwise than by observing that it shall be no greater than shall suffice to render the acid taste just perceptible. Sometimes I add the water alone, and after allowing a sufficient length of time for it to take up all the soluble matter, which may be from three to four hours when cold water is used, but a much shorter period will suffice with hot water; I drain off, and press out the solution from the residual matter, and then add thereto the sulphuric acid, as before directed. In the former mode, but little of the mucilage and coloring matter is taken into solution; in the latter, they are precipitated, or so far disengaged from their combination with the sugar, that they separate in the form of scum, and are readily removed when the liquid is boiled.

The liquid thus prepared, is to be put into a boiler, and placed over a fire, a portion of the white of eggs, or other fining being added. When brought to a boiling heat, a scum will rise, which is to be removed after damping, or taking the kettle from the fire, which is to be repeated as long as any scum rises.

The next operation is to filter the liquor through animal charcoal, [ivory or bone black.] A stratum of two or three inches in thickness will suffice for every useful purpose, when the previous preperation has been used as above directed. The sirop will come through perfectly fine, and nearly as colorless as water; there will, however, be a very slight yellowish green tinge, resulting, apparently, from the presence of a peculiar principle in the beet; this material separates when crystallization takes place; although its quantity is minute, and its weight scarcely appreciable, it will if left among the crystals, occasion an adhesiveness of the particles, and a tendency to deliquescence; it should therefore be got rid of, and this is easily effected. All that is necessary is to pour a quantity of white sirop upon the crystallized sugar after it has been pressed, so as to moisten it throughout, and then press it again. This operation requires but little time, and should be repeated until the sugar is fit to pack.

The evaporating of the water from the sugar, preparatory to its crystallization, may be in great part performed over an open fire without danger of injury; it may be completed by placing the evaporating pan in a vessel of water kept at about 150° of Fahrenheit's thermometer. When this is performed early in the season, or by taking beets which have been frozen and dried at the proper time, there will not be the smallest portion of molasses produced, the whole of the sugar being crystallizable. In very cold weather, a large part of the water may be removed in the form of ice, by allowing it to freeze, and much labor and fuel be thus saved.

When the clarified sirop is sufficiently concentrated, small brilliant crystals will appear upon the sides and bottom of the vessel, and a crust soon

forms over the surface of the liquor; the crystals go on increasing in size, and that portion of the sirop from which the air is excluded continues in a perfectly clear and liquid state; but if the sirop be at this time stirred, it becomes opaque, and of milky whiteness; a deposition of fine white sugar then takes place, and whatever of impurity may have remained in the liquor will rise to the surface; this portion crystallizes more slowly than the other, but by drawing it off, and again exposing it to heat, it will readily form good sugar.

Having thus fully described the process which I pave devised for the manufacturing of beet sugar, I do hereby declare, that what I claim as my invention, and desire to secure by letters patent, is the preparing of the beets for the subsequent steps of the process, by exposing them, in thin slices, to the action of frost, after which they may be directly thawed, and submitted to pressure; or they may be dried by a current of cold air, and treated in the manner set forth, at any convenient time; it being always observed, that when the process for the extraction of the sugar is commenced, it must be completed without delay, as upon this depends the ability to produce the sugar without molasses, and without the employment of lime to correct acidity.

JOSEPH HURD, JR.

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## SPECIFICATION OF A PATENT FOR A PROCESS FOR ALLOYING METALS BY CEMENTATION; GRANTED TO M. SOREL OF PARIS IN THE KINGDOM OF FRANCE SEPTEMBER 12TH, 1838.

To all persons to whom these presents shall come, M. Sorel, of the kingdom of France, gentleman, sends greeting. Be it known that I, the said Sorel, have invented, constructed, made and applied to use, a new and useful process for alloying metals by cementation, applicable particularly to the preservation of copper, iron and other metals, and also operating a change in their outward appearance, and giving them more gloss; which process is specified in the words following, viz:—

The said process consists in alloying the surface, or even the mass of copper either with *zinc, tin, lead, or other metals more fusible than copper*, and capable of being alloyed with the same. These various metals may either be employed singly or in combination, but I have obtained the best results, in every respect, from the use of zinc alone. By an analogous process, I also alloy iron and other metals, as herein fully described and made known.

The mode of cementing zinc with copper may also be employed for the cementation of other metals; I begin by scouring the metal I wish to alloy, or cement; I surround it afterwards with pulverized charcoal and zinc.—The zinc is prepared for that purpose by forming an alloy between the said metal and iron, which alloy may be easily reduced into powder. Zinc minutely divided by other means may also be employed.

The copper thus surrounded, or covered, is placed in a furnace, where it is to be raised to a red heat, and the same temperature must be kept up during a longer or shorter period of time, according to the dimensions of the pieces of coper operated upon, and the depth to which it is desired to operate the cementation. It is however proper that the operation should not last too long, as, on the copper, there might then be formed a coating of brass, which would be liable to corrode, and to produce verdigris; which defect may be obviated in two ways—1st, by stopping the operation before the alloying between the copper and the zinc be completely effected, and 2d, by sifting pulverized zinc over the substances which cover the copper, a few minutes before it is drawn from the fire.

In the process of cementation, just described, instead of the pulverized zinc, thin sheets of zinc may be substituted or even lapis calaminaris. When it is not required that the cementation should penetrate deeply into the copper, this metal may be previously coated with zinc, according to the usual process of tinning, and then submitted to the cementing process as above described.

This process of cementation is applicable to all metals in the rough or the finished state such as copper, brass, bronze, melchoir or German silver and is of much importance in metallurgy. Among thousands of applications, may be mentioned the preservation of the copper sheathing of ships, the preservation of medals and other precious articles of bronze, the cleanliness, and consequently the salubrity, of culinary utensils.

It is worthy of remark that zinc, which by itself is so easily corroded by acids, becomes quite proof against sulphuric acid in the cold state, let it be ever so concentrated, provided the cementation of zinc and copper be stopped at the proper point to avoid the formation of brass; while on the other hand, zinc alloyed by fusion with one half or one third, of its weight of copper is dissolved by sulphuric acid as rapidly as if it were pure and unalloyed.

The application to iron of the process of alloying by means of cementation is to be next explained; this process preserves iron from rust, and moreover, gives to wrought, or to cast iron, the appearance of gold or of silver.

With an alloy of copper and zinc in different proportions, and by prolonging the operation, more or less, a gold or silver color is given to the iron operated upon. These colors are brilliant and lasting, and do not produce verdigris, and the metal resists the action of sulphuric acid more or less diluted with water. The process is a follows, and consists of two operations, which though analogous in their effects, are yet different from one another.

*Firstly*, the iron must be covered by immersion in the fused metal which is intended to be used as a coating: *secondly*, the iron must be alloyed by means of cementation, with the metal which has been thus made to cover it. This last operation, gives to the coated metal new properties, and renders its surface more smooth.

To coat iron with an alloy of copper and zinc, I melt about two parts of copper with three parts of zinc, and I dip in this alloy, while in a fused state, and covered with borax, or other suitable flux, the pieces of iron I wish to prepare. These pieces must be well scoured, or previously coated with zinc. If the pieces be very massive, they must be heated before being dipped in the fused metal. By way of lessening the quantity of borax necessary to the process, a saturated solution of this flux may be made, and brought to the boiling point, and the pieces are then immersed in this solution before being introduced into the fused metal. When extracted from the melted metal, the pieces of iron will not have yet assumed the color of copper, and their surface will be rough, but a second operation imparts to them the proper color, and removes the aspereties.

The second operation is a follows: the pieces of iron which have been submitted to the first operation, must be covered with powdered charcoal, and exposed to a red heat, for a longer or shorter space of time, according to the color and the result to be obtained. The iron is better preserved from rust when the operation is rapidly effected, but in that case the color is not so good.

The pieces of iron must be drawn from the furnace along with the charcoal which covers them, and in that state immersed in water, and allowed to cool.

The second operation may be effected in a reverberatory furnace.

The same process may be modified so as to dispense with the previous coating of zinc given to the iron; to effect this an alloy of zinc and copper is made with the same proportions of each metal, indicated for the first process. When cool, this alloy must be reduced to powder in a mortar, and a certain quantity of borax must be added. The pieces of iron to be operated upon, must be scoured, and covered with a greasy, or viscous substance, or merely wetted with water; they are next strewed with the pounded alloy and borax, and finally imbedded in powdered charcoal in the same manner as in the second part of the first process; they must be heated long enough to allow the excess of zinc to evaporate. It is easy to ascertain that the operation is terminated when only a small quantity of vapor escapes from the mass. The pieces of iron are then drawn from the fire and thrown, while red hot, and still covered with charcoal, into water. After this immersion, the iron is completely coated with copper, the brilliancy of which may be increased by dipping it into nitric acid containing a little soot; it may then be burnisned, polished, and even gilded exactly as if it were massive copper.

I shall finally describe a second modification of the process for alloying iron with another metal by cementation; first, scour the iron perfectly, immerse it in a solution of sulphate of copper, and let it remain therein during a greater or less period of time, according to the thickness of the copper coating which it is desirable to obtain; the copper precipitates on the iron, and when the covering is sufficiently thick, the pieces operated upon must be taken out of the solution and covered with very fine clay, softened in water; over this are strewed borax and zinc, pulverized and mixed together; instead of strewing borax and zinc powder in this way, a paste may be made with clay, borax and zinc powder, and the pieces of iron be covered with the same.

The pieces of iron are next to be buried in powdered charcoal, and exposed during a few minutes to a white heat. They may then be withdrawn from the fire, and they will be found to be covered with a coating of the alloy, containing a greater or less proportion of zinc, according to the proportion contained in the powder employed, and the duration of the process.

What I claim as my invention, and desire to secure by letters patent, is the manner herein described of cementing copper, and other metals, or mixture of metals, with zinc in the manner, with the limitations, and for the purpose set forth. I also claim the manner of protecting iron, by the process, or processes herein fully described and made known, together with such modifications of said process, or processess, as are substantially the same in their nature and effects. M. Sorel.

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Norwich Railroad.—During the present week the rails will be laid from Norwich to a station in Pomfret, about thirty-three miles. The cars have pased for some time from Norwich to Killingly, twenty-six miles, and the amount of transportation has been found to exceed the estimates previously formed of its amount. From the nothern termination of the road, ten miles have been completed from Worcester to Oxford. Operations are carried on over the other portions of the road with vigor, by large companies of operatives. The loss of a ship loaded with iron sufficient for six miles of the road, although it will not occasion pecuniary loss to the corporation, may make some loss of time in the completion of the work; new materials may be procured by purchase, it is supposed, in this country; if so, the whole undertaking may be completed within a few weeks.—*National Ægis.*

Locomotives applied to Canal Navigation.—The experiments for testing the substitution of locomotive engines for horses in the hauling of boats and vessels on canals, were repeated on the 11th instant, upon the experimental ground, prepared near lock 16, on the Fourth and Clyde canal. They were conducted, as before, under the superintendence of Mr. M'Neill, C. E.

At this trial there were present, the governor, part of the committee, and the manager of the Forth and Clyde canal company, and several professional and scientific persons.

The locomotive engine was the one which had been used in the previous experiments. It was attached, successively, to passenger boats, lightly and heavily laden; and to sloops, singly and two together. The passenger boats almost instantly attaining velocities of 16 and 17 miles per hour; and these were maintained with a very small expenditure of steam. The wave produced by this rapid movement of the boats through the water, was very different from that which has been observed in all velocities hitherto accomplished on canals, and altogether unlike the one which theoretical investigation had prepared us to look for. It did not undulate and rush along the banks but proceeded direct from the boat side to the shore, striking the latter at right angles, or very nearly so. It was by no means increased in an equal proportion to the increase of velocity, but on the contrary, when highest, was evidently less than that which the passenger boats ordinarily produce. The sloops varied from 70 to 90 tons, and were moderately laden, but their draught of water was not less than eight feet. They were hauled at velocities, the highest of which was limited to 3½ miles per hour. Much higher could have been given (as was actually done in the previous experiments,) but this was considered to be a rate which would never be desirable for this class of vessels to exceed.

In every case the results were perfectly satisfactory and fully confirmed those given by the experiments of the 21st and 22nd ultimo. They left no doubt that velocities suitable to every kind of vessel were easily attainable, that these velocities might range from 2½ miles to 20 miles per hour, and that when the machinery and management should be perfected, and have become familiar by experience, it was more than probable that 25 and even 30 miles per hour might be safely accomplished.

The decided success of this step, necessarily made under the disadvantageous circumstances attending a first essay, has induced the Forth and Clyde canal company to resolve that the principle shall be carried immediately into practice. This company will therefore attain the honorable distinction of introducing an improvement pregnant with the most beneficial consequences to inland navigation.—*Eng. Paper.*

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The Galvanic Telegraph at the Great Western Railway.—The space occupied by the case containing the machinery (which simply stands upon a table, and can be removed at pleasure to any part of the room) is little more than that required for a gentleman's hat box. The telegraph is worked by merely pressing small brass keys (similar to those on a keyed bugle,) which acting (by means of galvanic power) upon various hands placed upon a dial plate at the other end of the telegraph line, as far as now opened, point not only to each letter of the alphabet (as each key may be struck or pressed) but the numericals are indicated by the same means, as well as the various points, from a comma to a colon, with notes of admiration and interjection. There is likewise a cross (x) upon the dial, which indicates that when this key is struck a mistake has been made in some part of the sentence telegraphed, and that an "erasure" is intend-

ed. A question—such as the following—"How many passengers started from Dryton by the ten o'clock train?" and the answer, could be transmitted from the terminus to Dryton and back in less than two minutes. This was proved on Saturday. This mode of communication is only completed as far as the west Dryton station, which is about thirteen miles and a half from Paddington. There are wires [as may be imagined] communicating with each end, thus far completed, passing through a hollow iron tube, not more than an inch and a half in diameter, which is fixed about six inches above the ground, running parallel with the railway, and about two or three feet distant from it. It is the intention of the Great Western railway company to carry the tube along the line as fast as completion of the rails takes place, and ultimately throughout the whole distance to Bristol. —*English paper.*

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How Holland was formed.—The manner in which the country has been rendered habitable to human beings, is one of the most surprising facts in physical geography. The whole of the territory, from the Texel to the north, to pretty nearly Calais on the south, comprehending a large part of Holland and Belgium, and part of France, is in almost all parts perfectly level, and if it had not been indebted to art, would have been a general marsh, or included within the influence of the sea. On looking at this extensive territory, and then proceeding inland to the higher regions of Germany, the conclusion naturally arises, that the whole of the low countries are simply an alluvial deposit, washed from the alpine regions of the interior. The land every where on being dug, is sand or clay. You may travel hundreds of miles and never see a stone. At this hour land is forming on the coast of Holland, and by a very obvious process. The waters of the Rhine, in all its branches, are very muddy, or loaded with particles of clay and sand, washed from the upper country, and these are carried out to the sea, where they are sinking to the bottom, and forming sand banks. At the mouth of the Maese, long sandy beaches, produced in this manner, are seen at certain states of the tide. Already they exhibit tufts of herbage, and are resorted to by flocks of sea-birds; and there can be no doubt, that, by a very little trouble, many square miles of new land might at present be added to the coast of Holland. The exact process by which the low countries have been saved from the sea, has never yet been fully detailed. Nature having in the first instance produced an alluvial marsh, a certain degree of art has been employed to raise barriers to prevent the influx of the sea; and this point being secured, the next step has been to drain the land, piecemeal by pumping, the water being raised so as to flow off by channels into the sea at low tide. Much stress is usually laid by writers on the prodigious trouble taken by the Netherlands to keep out the sea, by means of artificial bulwarks along the coast. But on this point there is some exaggeration, and one very material circumstance is entirely omitted to be noticed. It is only at certain places that great exertions are made, by means of artificial dykes, to keep out the sea. Nature, as if anxious to save the country from tidal inundation, has for centuries been energetically working to increase the magnitude of the mounds on the coast. At low water, when the bare beach is exposed to the action of the winds from the German ocean, clouds of sands are raised into the air, and showered down upon the country for at least a mile inland; this is constantly going on, and the result is that along the whole line from Haarlem to about Dunkirk or Calais, the coast consists of sandy mounds or downs, of great breadth partially covered with grass and heath, but unfit for pasturage or any other purpose. In some places those downs look like a series of irreg-

ular hills, and when seen from the tops of the steeples, they are so huge as to shut out the view of the sea. The traveller in visiting them from the plains all at once ascends into a region of desert barrenness. He walks on and on for miles in a wilderness such as might be expected to be seen in Africa, and at last emerges on the sea shore, where the mode of creation of this singular kind of territory is at once conspicuous. Loose particles of sand are blown in his face; and as he descends to the shore, he sinks to the ancle in the drifted heaps. In some parts of these dreary solitudes, the sandy soil has been prevented from rising with the wind and injuring the fertile country, by being sown with the seeds of a particular kind of benty grass, and in a few spots fir trees have been successfully planted.—*Chamber's Continental Tour.*

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SPECIFICATION OF A PATENT, GRANTED TO WILLIAM DOLIER, FOR A CERTAIN DURABLE SURFACE OR TABLET FOR THE PURPOSE OF RECEIVING WRITINGS, DRAWINGS, OR IMPRESSIONS OF ENGRAVINGS, OR OTHER DEVICES CAPABLE OF BEING PRINTED, WHICH SURFACES MAY BE APPLIED FOR ROADS OR PAVEMENTS, AND STRENGTHENING AND BEAUTIFYING GLASS.

My invention of a certain durable surface or tablet, for the purpose of receiving writings, drawings, or impressions of engravings or other devices capable of being printed, consists, firstly, in the application of a well known composition or material as a durable tablet or surface for receiving writings or drawings, and which may be removed at pleasure by moisture.

This composition or material is common glass enamel, made in the ordinary manner from flint glass, borax and arsenic, and which I roll out in thin plates of any required dimensions, exactly similar to manufacturing plate glass; and after it has been ground and polished, I remove the glazed surface by grinding with the finest emery powder, and then the tablet is ready for use. This permanent tablet will now be found capable of receiving the finest writing or drawing, and also beautifully adapted to receive paintings and impressions, exactly in the same manner as ornamenting china by painting or transfer.

This improved tablet will be an elegant appendage to various domestic purposes and furniture, and may be manufactured into sideboards, billiard tables, table tops, and all other similar ornamental purposes; and may have either a highly polished, or a dead surface, and may be composed of any variety of colors by altering the ingredients of the enamel, which is well understood.

My second improvement in a durable surface, is in rendering the same perfectly pliable, and still rendering such surface durable. This is composed by a foundation of a sheet of linen, silk, cotton or other cloth, linen being preferable, to be coated, or covered upon one side with a mixture, or composition and treated as follows:—spread upon the reverse side of the sheet of linen, one coat of a size or varnish, made by dissolving one pound of buffalo skin in one gallon of water over a slow fire, and let the other side, when dry, be rubbed with pumace stone, in order to remove all inequalities and leave the surface perfectly smooth. This surface is now to be coated three times with a mixture of the purest white lead, called flake white, with boiled linseed oil and spirits of turpentine, in about the proportions of one pound of white lead to one quart of oil and half a pint of turpentine. After this has become perfectly dried, the flexible surface is ready for use, and is most suitable for printing, and particularly advantageous for receiving impressions of maps or charts for marine and general purposes,

as being permanent and durable. The back, or reverse side of this prepared cloth may be flocked with pulverized woollen cloth in the usual manner of flocking paper hangings, which will improve its appearance and make it more suitable for ornamental purposes. Gold, silver, or bronze surfaces may also be given to the cloth thus prepared, by giving it a coat of the buffalo size, and dusting the metalic powder over it.

Thirdly, these improvements are applicable to roads and pavements for bath rooms and other similar situation, or tesselated pavements, where damp or wet is liable to get between the joints of the pavements, and form unhealthy and improper secretions; and consist in putting together squares of such enamelled surfaces as first above described, or common bath tiles in squares in different colors and devices, and cement or cover the joints with a light coating of glass enamel fused over the joints in order to render them perfectly secure; and in all situations where cleanliness and beauty are required, this will be found particularly useful.

A further application of this invention may be made by having engraved or printed maps, or other designs, made upon the under side of plates of glass, and vitrifying the glass to render the design permanent, and paving rooms with such plates or squares for the purposes of recreation; and also by inserting rails of glass, either in bars, rods, or plates set edgeways in grooves or sleepers of wood or metal, making such rails either portable or permanent, and also intended as applicable to various amusements which may thus be pursued in gardens or other situations.

The fourth feature in my invention relates to the strengthening and beautifying glass, and consists in preparing sheets or plates of glass in the usual manner, and placing between two plates a metalic web of wire, wrought into any form or design that may be desired, and then partially fusing the glass so that the glass shall run between the meshes or interstices of the metallic design, and thus consolidate or embody the whole into one plate of glass, with the metallic design in the centre.

The metallic web or design may be formed of either plain net, or any other elegant scroll work or other design, and be composed of brass plated, or other metalic wire, and cast into any form or device which shall be required, and the glass fused around it, and rolled or pressed in the ordinary manner of manufacturing plate glass.

Another adaptation of these improvements is particularly applicable to ornamental windows and casements, where the glass is not required to surround the metal upon all sides. A suitable casting is to be prepared in brass, iron or other metal, of the exact form of the window frame required; for instance, an ornamental Gothic window, and this casting is to be the frame work of the window. The glass is then to be cast in its fluid state into the metallic framing, and may either be rolled of such a thickness that the metal frame shall be in the centre of the plate of glass, or it may be rolled down until the glass shall only fill the interstices of the metalic framing; and thus in in either case, the whole of the panes or compartments of an ornamental window may be made in an entire piece, and of any variety of form, strength, or beauty. The glass is afterwards to be annealed in the usual manner, and then submitted to a bath of cold linseed oil, which is to be caused gradually to boil, and after removing from the fire and allowed to cool, which will thus form a second annealing, and also regulate the expansion and contraction of the metals. The glass is to be ground up and polished in the usual manner, and may either be made bright for windows or rendered opaque to be employed for all useful and ornamental purposes for furniture, to be used instead of the finest marbles, and with equal beauty and effect.

This combination of metals with glass, for the purpose of increasing its strength, will be of material importance for "dead lights" for all marine purposes, and also forming perpetual window blinds; and it will be evident that great strength may thus be given to glass for windows and such similar purposes by either of the processes above described.—*London Journal of Arts and Sciences.*

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SPECIFICATION OF A PATENT GRANTED TO EUGENE RICHARD LADISLAS DE BREZA FOR A CHEMICAL COMBINATION OR COMPOUND FOR RENDERING CLOTH, WOOD, PAPER AND OTHER SUBSTANCES INDESTRUCTIBLE BY FIRE, AND ALSO PRESERVING THEM FROM THE RAVAGES OF INSECTS.

The chemical compound alluded to in the title of this patent, consists of the following materials, and is mixed in the following proportions:—for linens and unbleached goods, take two pints and a half of water, and after raising the temperature to 190 degrees of Fahrenheit's thermometer, add one ounce of alum, with one ounce and a half of sulphate of ammonia, half an ounce of boracic acid, one drachm of glue, the best and finest that can be procured, and add to the whole one drachm of starch dissolved in a small quantity of water.

Before the starch is added, the temperature of the mixture should be raised to at least 212 degrees of Fahrenheit; care should be taken that the several ingredients are introduced in the order above mentioned, and also that each one is dissolved in the water before the next is added. The mixture being thus prepared, the goods to be preserved are operated upon in any suitable manner; for instance, plain unbleached goods may be immersed in the compound, and be allowed to absorb as much as possible, after which they must be pressed or rung hard, in order to get rid of the redundant liquor; they are then dried in any convenient manner. Printed goods when the colors are fast, may be treated in the same manner; but when the colors are not fast, the mixture should be applied with a sponge, care being taken that they are not wetted too much, otherwise the colors may perhaps run.

When timber is to be operated on, it is to be put into tanks, and covered over with the mixture, which is raised to a temperature of at least 160 degrees.

For preserving paper, or pasteboard, the mixture may be put into the vat containing the pulp from which the paper or pasteboard is to be made, or, the paper may be immersed in the mixture after it is manufactured.

When the invention is to be applied to theatrical scenery already in use, sheets of paper prepared in the manner described, should be pasted at the reverse side; but for new scenery, the canvass may be steeped in the solution.

It is observed that it is not to be supposed the said composition will render the various articles indestructible by fire, but that it merely prevents them from bursting into flame, and by that means communicating the fire from one thing to another.

In conclusion the patentee states that he is aware that some of the ingredients above mentioned have been used for similar purposes to those which his invention is intended to be applied; but what he claims as his invention, is the making a composition consisting of alum, sulphate of ammonia, boracic acid, glue and starch, mixed in the above order and proportions, to be applied to various articles, and which composition will render them indestructible by fire, and protect them from the ravages of insects.—*Idem.*

SPECIFICATION OF JAMES CALDWELL, IN THE COUNTY OF MIDDLESEX, COAL-MERCHANT, FOR CERTAIN IMPROVEMENTS IN CRANES, VESSELS, AND APPARATUS FOR DELIVERING COALS FROM SHIPPING TO WHARFS, WAREHOUSES, WAGONS, AND OTHER PURPOSES.

The invention specified consists in a certain arrangement of mechanism, by means of which two men will be enabled to raise about nine hundred weight of coals at one time from the hold of a vessel, and deposit the same in a cart; parts of such mechanism, together with the weight of the men acting as a counter-balance, and facilitating the delivery of the coals or other burden.

The peculiar arrangement of parts for effecting this will be understood from the following description :—An upright standard or pillar, properly and firmly secured both at top and bottom, is affixed to the deck of a ship, or in any other convenient situation, and upon one side of this pillar a toothed rack is formed. A moveable platform is connected to the pillar in any convenient manner, and slides up and down in a groove formed on it. A pinion, which is mounted in some part of the moveable platform, gears into the toothed rack formed on the pillar; and to the axle of this pinion a winch handle and brake wheel is attached. A rope, connected to the moveable platform, is passed over a pulley mounted at the top of the pillar, the reverse end of the rope being fastened to the coal box below. Two ratchet racks, having clicks connected to the platform taking into them, are placed one on each side of the toothed rack before mentioned, in order to prevent the platform from running down, and to retain it in any elevation that may be required.

When the machine is required for use, the men on the platform turn the winches in order to raise themselves to such an elevation as will lower the coal box to the required depth in the hold; and when the box is full they turn the handles the reverse way and begin to descend, and, consequently, raise the coal box.

It will be readily understood that if the weight of coals to be raised is nine hundred weight, and if the moveable platform with its appurtenances, together with the men, weigh five hundred weight, then the power to be employed need not exceed that required to raise four hundred weight in the ordinary manner, as the weight of the platform and the men will materially assist the ascent of the coal box.

The box for containing the coals is so contrived that the bottom may be moved or tilted up, so that the coals may drop through; and according to the drawings, it seems to be divided into four compartments, probably for convenience of filling sacks. The first part of the invention may be applied to raising other weights.

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SIDE MOTION (OR ROCKING) OF RAILWAY ENGINES EFFECTUALLY PREVENTED.

Sir.—My attention having been drawn to the lateral and shaking motion of engines upon railways, and believing it to be in proportion to the weight of the cranks and gearing, and the position in which the outside cranks, if any are placed, I made a small model of the engine crank shaft with two wheels upon it, in the proportion of one inch to the foot, which I placed upon two strong upright wires, the wires made fast in a piece of board. I attached a weight to a string wrapped round the middle of the crank shaft, for the purpose of giving a certain degree of velocity to the crank and wheels, by falling a certain distance, say from the table to the floor. The weight I attached would turn the shaft and wheels seventy-five seconds,

and the swing of the cranks produced *a lateral and oscillating motion* sufficient to cause the model to move, or jump, across the table on which it was placed. I then placed a weight on each wheel sufficient to *balance the cranks,* and with the same weight to give motion, and travelling the same distance as in the first case would turn the crank shaft and wheels, although heavier than before, 90 seconds, and the model stood steady where it was placed upon the table.

I submitted my experiments to the engineers of the London and Birmingham railway, who, instructed by the directors, ordered one of the company's engines [the Brockhall, at that time under repair at Mr. Middleton's the Vulcan iron foundry, Birmingham] to have ballance weights applied to it, according to my plan, and under my superintendence. The engine, when set to work, with the ballance weights on the wheels, had one uniform steady pull at its work; the side sway was gone; it run equally steady whether it made 6 or 160 strokes per minute, which is not the case with railway engines generally, for the greater the speed, the greater the snatching and swinging motion. After the engine had worked seven weeks, and had acquired the reputation of a very steady engine, I, with the consent of the engineers of the railway, removed the *balance weights* from the wheels and found the same snatching and swinging motion with this engine as is common to all locomotive engines of the usual construction; I found that the engine, when running at or upwards of 22 miles per hour, would advance and recede from and to the tender from three-quarters of an inch to an inch every stroke of the engine and proved the advantage of the ballance of the engine equal to the effect on the model. Persons acquainted with railway locomotion will from the foregoing statements readily see the great and many advantages to be derived from so simple and yet so effective an arrangement.

Yours respectfully, G. Heaton.

P. S.—Since writing the above, I understand the spirited and enterprising manufacturers of the Brockhall engine, have judiciously applied my balance weights to some new locomotive engines lately sent out by them.—*London Mechanics Magazine.* G. H.

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## THEORY OF THE STEAM-ENGINE.

### CHAPTER I.—PROOFS OF THE INACCURACY OF THE ORDINARY MODE OF CALCULATION.

*Section I.—Mode of calculation now in use, to calculate the effects of a steam-engine.*

The object of this work is to demonstrate that the calculation of the effects or the proportions of steam-engines, either as it is practically used or as it is found indicated by authors who have treated this subject, is completely erroneous, and to develope a new theory which leads to accurate results. Our first chapter, then, will necessarily be devoted to proving the inaccuracy of the ordinary methods of calculation. From that we shall pass successively to the development of the theory proposed, and its application to the different systems of steam-engines in use.

The effect produced by a machine consists of two elements: the resistance set in motion, and the velocity communicated to that resistance. Hence results, that the calculations which first occur in the application of machines refer to the two following problems:

1st. The machine being supposed constructed, and the velocity of its motion given, to determine what resistance it can move.

2d. The machine being supposed constructed, and the resistance it has

to move being known, to determine the velocity it can communicate to that resistance.

A third problem then presents itself as a natural consequence of the two preceding, viz.:

3d. The resistance being known as well as the velocity to be communicated to it, to determine the dimensions that ought to be adopted in the construction of the machine, in order to produce the effect proposed. In steam-engines, this third problem reduces itself to determining the size of the boiler, or, in other words, the evaporation it should be capable of, in order to obtain the effect proposed.

These three problems are the basis of all calculations on steam-engines. They may take divers modifications and give rise to several questions, which hereafter we shall notice, but whose solution will entirely depend on that of the three fundamental problems just mentioned. Thus, for instance, to find the useful effect of an engine of which the number of strokes of the piston is counted, that is, whose velocity is known, amounts to determining the resistance it can move at that velocity; since that resistance being once known, it suffices to multiply it by the given velocity, to have the useful effect required. The horse-power of an engine, and its effect for a given weight of fuel, being nothing more than the useful effect of the engine referred to particular units; that is to the power of the horse considered as the unit of force produced, or to the consumption of a certain quantity of fuel considered as the unit of force applied; it is plain that these questions merge into that of the useful effect. This point, however, will be readily recognized when we come to treat specially of these questions.

Thus all inquiries relative to steam-engines reduce themselves finally to the three just announced: to find the load, to find the velocity, to find the evaporation.

The only mode of calculation hitherto in use to estimate either the effort of which a steam engine is capable, or the useful effect it can produce, is first to perform the calculation under the supposition that the steam acts in the cylinder with the same elastic force as in the boiler, and without regarding the friction of the engine; then to reduce the result in a certain proportion indicated by a constant coefficient. This method, which we shall name the method of *coefficients*, was resorted to, because there being no means of knowing, *a priori*, the pressure of the steam in the cylinder, it was naturally enough at first concluded to be equal to that of the boiler. But as the result thus obtained, and which was called the *theoretic* result, was invariably found much higher than the *practical* results compared with it, a reduction was found to be necessary.

The necessity of this reduction was attributed to two causes: 1st, to the friction of the engine having been neglected in the calculation; and 2nd, to no account having been taken of losses resulting from the five following circumstances: the contraction of the passages through which the steam has to pass, the changes in the direction of the conducting pipes, the friction of steam in the steam-pipes, the waste of steam, and its partial condensation. And as these causes seemed likely to act similarly, not only in the same engine, as long as the passages of the steam were not varied, but in all engines of the same system, it was natural to suppose that they would produce on the definitive result of the calculation, a reduction proportioned to its total value.

It was in consequence judged, that the real result might be attained by reducing the theoretic result in a certain constant proportion. It had been observed, also, that the ratio of the theoretical and practical effects was not

the same in the different systems of steam-engines; this consequently led to the admitting of a different coefficient for each system.

This mode was the most natural, it was even the only one possible, so long as means were wanting to determine beforehand what would be the real pressure of the steam in the cylinder under given conditions. And notwithstanding we have undertaken to demonstrate the errors which result from the application of that calculation, and to substitute another in its place, we are far from wishing to depreciate the works in which that calculation is developed. It was felt, no doubt, that that method, from the very circumstance of its consisting in the use of a coefficient to represent in total, various effects which had never been submitted to direct admeasurement, could be but an approximation, a mere provisional method. It was used as we use a bad instrument, till we can get a better. Many of the works wherein it is explained, acknowledge at the same time that the theory of the steam-engine is as yet unknown, or imperfectly studied. Moreover, these works do not all treat the subject in a manner perfectly similar, and therefore the observations we are about to make, cannot be addressed equally to all. We wish it, then, to be clearly understood, that in comparing the two calculations together, when it shall be needful so to do, our end is to establish the accuracy of the method we propose, and not to attack the writings of others.

To return to the method in use, this was the proceeding. The force applied to the piston was computed, in supposing the pressure of the steam in the cylinder equal to that of the steam in the boiler: that is to say, the area of the piston was multiplied by the pressure of the steam in the boiler, which gave the force exerted by the engine; this result was then multiplied by the velocity of the piston, and thus was obtained the *theoretic* effect of the engine. But the result of this calculation having been compared with that of some experiments made on engines of the same kind, the ratio between the two results had furnished a fractional coefficient, which was regarded as the constant ratio between the theoretical and practical effects of all engines of the same system; therefore, in multiplying the number expressing the theoretic effect by this fractional coefficient, a definitive product was obtained, which was the *practical* effect that could be expected from the engine.

Supposing, for instance, an engine without condensation, and expressing the area of the cylinder by $a$, the pressure of the steam per unit of surface in the boiler by $\pi$, and the velocity of the piston by $v$; $a\pi$ was the force applied by the engine, and $a\pi v$ the theoretic effect it ought to produce. As then some experience, instead of giving an effect equal to $a\pi v$, had given but a certain fraction of it, which we will express by $k$, the coefficient $k$ was admitted as representing the constant ratio between the theoretical and practical effects. So that the useful effect of a non-condensing engine was represented by $ka\pi v$; or the theoretic effort of the engine being expressed by $a\pi$, its useful effort, or the resistance the piston could move, was represented by $a\mathrm{R}=ka\pi$, R expressing that resistance supposed to be divided per unit of the surface of the piston.

The coefficients indicated by Tredgold, in order to pass from the pressure in the boiler to the part of it which is applied to produce the useful effect, are the following:

| | |
|---|---|
| Non-condensing unexpansive engines | ·60 |
| Non-condensing expansive engines | ·60 |
| Non-condensing expansive engines, with two cylinders | ·47 |
| Watt's single-acting engines | ·60 |
| Single-acting expansive engines | ·60 |
| Watt's double-acting steam-engine | ·63 |

Double-acting engine, with two cylinders ·48

Atmospheric engine (coefficient to be applied to the atmospheric pressure, and including a deduction for the pressure of the uncondensed steam on the opposite side of the piston) ·52

Atmospheric engine, with a separate condenser (coefficient to be applied like the preceding one) ·54

It must be understood that these coefficients, excepting those for the atmospheric engines, are to be applied to the *total* pressure of the steam in the boiler; that is, before any deduction is made, either for the pressure of the uncondensed steam or for the atmospheric pressure, on the opposite side of the piston. If, on the contrary, before applying the coefficient, the pressure in the boiler had been diminished by the pressure subsisting on the other side of the piston, in order to deduce first what is called the *effective* pressure of the steam, then other coefficients, smaller than those indicated here, ought to be used. For instance, if we suppose a high pressure steam-engine working at the *total* pressure of 65 lbs. per square inch, and that we apply to that pressure the coefficient ·60, we shall have for the useful part of the total pressure $65 \times \cdot 60 = 39$ lbs.; and if we deduct from this force, the atmospheric pressure which acts on the other side of the piston, the practical effort applied by the engine will be $65 \times \cdot 60 - 15 = 24$ lbs. But as the *effective* pressure of the steam in the boiler is $65 - 15 = 50$ lbs., it is clear that, if we had had to pass from the *effective* pressure of the steam to the practical effort applied by the engine, a coefficient of ·50 ought then to have been used, instead of the coefficient ·60 applied to the *total* pressure in the boiler.

It is to be remarked also, that, as the theoretic effect of an engine is known only after deduction of the pressure on the other side of the piston, it follows that if the theoretic effect of the engine had been definitively calculated by this mode, and that we were to pass from it to the practical effect, it is the coefficient ·50 which ought then to be employed. Therefore, this last coefficient indicates in reality the reduction operated upon the *theoretic effects*, to conclude from them the *practical effects* of the engine; but the calculation comes to the same either way, provided a suitable coefficient be used.

Such was the solution of the first of the three problems above mentioned. The second, which consists in determining the velocity, had not been the object of any inquiry, by the mode of reasoning we have just exposed.

The third problem, or the evaporation of water necessary to produce a given effect, had been solved in a manner similar to the first. The rule consisted in calculating the volume described by the piston, and in supposing that volume to have been filled with steam at the same pressure as in the boiler, and then applying to it a constant coefficient. That determined in the preceding problem was usually employed, but it was applied as a divisor, with a view to augment the evaporation in proportion to the losses represented by that coefficient.

Thus, retaining the foregoing notations, and expressing by $m$ the volume of steam formed at the pressure of the boiler referred to the volume of water that produced it, we perceive that the volume described by the piston during the unit of time, was $av$. From the signification of the letter $m$ this volume of steam represented a volume of water expressed by $\frac{av}{m}$; but as it was deemed subject to a loss represented by the fraction or coefficient $k$, the volume of water really necessary to supply the expenditure $\frac{av}{m}$, became

$$S = \frac{av}{km}.$$

Such was the calculation in use; it solved, as we have seen, only two of the three fundamental problems. We shall, at a future moment, return to what regards the velocity of the piston under a given load.

Besides what has been said, the received ideas relative to the pressure of the steam in the cylinder, consisted in deeming that, the pressure in the boiler being given and fixed, it were possible at pleasure to vary the pressure in the cylinder and to produce there any desired pressure, provided it were inferior to that of the boiler, by contracting more or less the orifice of the steam-passages; and it was thought that, when this orifice was entirely open, with the area usually given to it in fixed engines, to wit, $\frac{1}{25}$ of the area of the cylinder, the pressure of steam in the cylinder could differ but in an inconsiderable quantity from the pressure in the boiler.

However, as the *indicator* of Watt, applied to the cylinder of several engines, had demonstrated a certain diminution of pressure therein, when compared with the pressure in the boiler, the authors who took this fact into account, without perceiving its real cause, still attributed it to the circumstances already explained, and it became merely one of the elements in the explication of their definitive coefficient. Thus, in all cases, the pressure in the cylinder was considered as being equal or proportional to that in the boiler, and therefore constant, so long as no change took place in the pressure of the boiler; but in no wise as being regulated by the resistance, or as variable with the resistance, independently of all pressures in the boiler, which we shall demonstrate that it in reality is.

*Section II.—Objections against that mode of calculation.*

The objections which first present themselves against that mode of calculation are the following:

1st. The coefficient adopted by many to represent the ratio of the theoretic effects to the practical, in high-pressure engines, was ·33; which was explained by saying that the remainder, or ·66 of the total force developed, was absorbed by the frictions and losses. Not that these frictions and losses had been measured and found such; but merely that the calculation, which might be inexact in its very principle, wanted so much of coinciding with experience.

To obtain conviction of the impossibility of justifying such an assertion as to the value of the frictions and losses, it suffices to peruse the explanation of it attempted by Tredgold, who follows this method.

He indicates that a deduction of 4 tenths should be made on the *total* pressure of the steam, (including the atmospheric pressure,) which amounts to making a reduction of ·5 on the ordinary *effective* pressure of those engines, or to using a coefficient of ·5 applied to the theoretic effect of the engine. He thus explains this loss in the effect produced.*

| | |
|---|---|
| Force necessary to bring the steam into the cylinder | ·007 |
| Force necessary to drive the steam into the atmosphere | ·007 |
| Loss from cooling in the cylinder and in the pipes | ·016 |
| Friction of the piston, losses, and waste | ·200 |
| Force necessary for the opening of the valves and the friction of the different parts of the engine | ·062 |
| Loss in consequence of the steam being intercepted before the end of the stroke | ·100 |
| | ·392 |

Reflecting that the numbers here given express fractions of the *total gross* power of the engine, we shall immediately be convinced of the im-

* Tredgold, Treatise on Steam Engine, Article 367.

possibility of admitting such estimates. If, for instance, the engine had a *useful* effect of 100 horse power, which, from the coefficient, supposes a gross effect of 200, it would require the power of 12 horses to move the machinery, of 40 to draw the piston, etc. The exaggeration is self-evident.

Besides, in applying this estimate of the frictions to a locomotive engine, which is also a high pressure engine, and supposing it to work at 60 lbs. effective pressure, or at 75 lbs. *total* pressure per square inch, we perceive that, were the cylinders 12 inches in diameter, or their surfaces 226 square inches, the force here reckoned as representing the friction of the piston would be $226 \times 75 \times {\cdot}20 = 3390$ lbs. Now, our own experiments on the friction of the mechanical organs of the locomotive engine the *Atlas*, which has those dimensions and which works at that pressure, demonstrate that the force requisite to move, not only the pistons, but all the other mechanical organs, including wastes, if it be true that such exist in an engine in good order, is but 48 lbs. applied to the wheel, or $48 \times 5{\cdot}9 = 283$ lbs. applied to the piston.*

It is impossible, therefore, to admit estimates so exaggerated as these; and what will it be, when it becomes necessary to explain a loss, not merely of half, but of two-thirds of the effect produced, as required by the coefficient ·33, adopted by many in practice, particularly for locomotive engines?

2d. This deduction, moreover, of two-thirds, considerable as it is, in very many cases does not suffice to harmonize the practical effects with the effects called theoretical.

In Wood's treatise on railroads, second edition, pp. 277—284, appears the calculation of five steam engines, not locomotive but stationary, two working at low pressure and three at high pressure, in which the real effects are to the theoretic, in the proportions represented by the following coefficients: ·26—·29—·31—·27 and ·30. Here then are examples, wherein it would be necessary to explain a loss of three-fourths of the total power of the engine.

But, with respect to locomotives, the difficulty becomes still greater, for it often occurs, when the load of the engine is light, that it would be necessary to apply a coefficient less even than ·25; and yet in these engines the steam passages have an area of $\frac{1}{10}$ instead of $\frac{1}{25}$ of the area of the cylinder; they are immerged in the steam of the boiler itself, which precludes all possibility of waste; the cylinders are in contact with the flame issuing from the fire-box, which entirely prevents condensation. Thus there remains only the friction to explain the enormous loss sustained, of more than ·75 of the total power; and this friction measured in our own experiments, as will be seen farther on, never rises above ·18 of what is termed the theoretic effect of the engine.

3d. It has just been said that, in locomotive engines, the coefficient would in certain cases sink below ·25. But there are other cases on the contrary, wherein, for the same engine, it would rise to ·80, examples of which may be seen in our *Treatise on Locomotives*, in all the cases when the engine drew a heavy load. Thus all the loss hitherto so laboriously explained disappears on a sudden.

4th. The measure of the theoretic effect of the engine results from three elements, to wit: the surface of the piston, the pressure of the steam, and the velocity of the motion. The causes which are said to explain the reduction to which this theoretic effect is liable, are: first, the friction of the engine, then the contraction of the passages, their changes of direction, the friction of the steam, its waste and its condensation. Now of the last

* Treatise on Locomotive Engines, second edition.

five causes, the condensation is the only one that can diminish the *pressure* of the steam during its passage, and that condensation is almost entirely obviated by the precautions used in practice: all the remaining causes of reduction act merely on the velocity. If then these causes produce definitively a reduction in the theoretic effect, it can only be by reason of their action on the velocity.

But, to calculate, by this method, the theoretic effect of an engine, the area of the piston is multiplied first by the pressure of steam in the boiler, which gives the theoretic effort; then this result is multiplied, not by the *theoretic* velocity of the engine which is unknown, but by its *observed* or practical velocity. All reduction then applicable to the theoretic velocity is, by the proceeding itself, already made in the calculation, and cannot be introduced into it anew.

Consequently, if notwithstanding the use of the practical velocity in the calculation, it be still necessary to retrench $\frac{2}{3}$ or $\frac{3}{4}$ from the result obtained, that loss of $\frac{3}{4}$ of the total effect must be due wholly to the friction, which is evidently impossible.

It is clear, then, that these inexplicable differences between the theory and the facts, can arise only from an error in the theory itself; that the results obtained from it are to be considered at most but as approximations, and not as being proper to determine, in an exact and analytical manner, either the effects or the proportions of steam-engines.

*Section III.—Formulæ proposed by divers authors to determine the velocity of the piston under a given load; and proofs of their inaccuracy.*

We have said that, in the above theory, the velocity of the piston under a given load, had not been made the object of a special research. Some essays had, however, been made to estimate this, but in a different manner.

1st. Tredgold, in his *Treatise on Railways*, (p. 83,) proposes a formula, without, however, establishing it in any way on reasoning or on fact. This formula is as follows:

$$V = 240 \sqrt{l \frac{P}{W}}.$$

V is the velocity of the piston in feet per minute; $l$ the stroke of the piston; P the effective pressure of the steam in the boiler; and W the resistance of the load. This formula, he says, will give the velocity of the piston. But as no mention is made therein, either of the diameter of the cylinder, or of the quantity of steam furnished by the boiler per minute, it clearly cannot give the velocity required; for if it could, the velocity of an engine would be the same with a cylinder of 1 foot diameter as with a cylinder of 4 feet, though the latter expends 16 times as much steam as the former. The heating surface, or evaporation of the boiler, would be equally indifferent. An engine would not move faster with a boiler evaporating a cubic foot of water per minute, than with another that should evaporate but $\frac{1}{4}$ or $\frac{1}{20}$. Hence this formula is unfounded.

2d. Wood, in his *Treatise on Railways*, (2d edition, p. 351,) proposes, also without discussing it, the following formula:

$$V = 4 \sqrt{l \frac{P}{W}}.^*$$

V is the velocity of the piston in feet per minute, $l$ the stroke of the pis-

* In the third edition of his work, which is just published, 1838, Mr. Wood abandons this formula to adopt ours, as also our theory in general, developed in the Treatise on Locomotive Engines, 1835.

ton, W the resistance of the load, and P the surplus of pressure in the boiler above what is necessary to ballance the resistance W. This formula, containing no term to represent either the diameter of the cylinder or the evaporating force of the boiler, is, like the preceding, demonstrated inexact *a priori.*

We know of no other attempt made to attain the solution of this problem, and these are altogether unsatisfactory.

Consequently, of the three fundamental problems which we have presented, two have received inaccurate solutions by means of coefficients, and the third remains unsolved.

*Section IV.—View of the theory proposed.*

We have so far demonstrated that there exists no analytical formula, nor any exact means for calculating the effects of steam-engines, and, consequently, for determining the proportions proper to be used in their construction, to obtain desired effects. A great number of engines are constructed and intended to fulfil required conditions; but the truth is, that, unless they have been designed after others already executed, their precise effects are not known till they are submitted to trial after construction, that is, when it is too late to apply a remedy. In a machine, the most powerful of all known, and which is tending to become almost universal, errors cannot be without importance. Not only such errors have been frequently prejudicial to vast manufacturing enterprises, and the occasion of difficulties between the builders and the purchasers of engines, but they have also compromised the lives of travellers; for when a steam-vessel has been found incapable of accomplishing its destined task, the only remedy to the evil that has occurred to the engineer, has been that of overloading, or even of making fast, the safety valve, and frightful explosions have often been the result. No doubt then can be entertained as to the usefulness of new researches on the subject.

After having exposed the state of science in what concerns the theory of the steam-engine, it remains to show on what principles is grounded the theory we are about to present.

We shall first explain this theory in all its simplicity, supposing the steam to preserve the same temperature throughout its action in the engine, limiting ourselves to rotative engines without expansion, and taking our basis on the consideration merely of the uniform motion which the engine necessarily attains after a very short lapse of time. A great number of theoretical and practical proofs will then corroborate the accuracy of our reasoning; and, finally, in the subsequent chapters, we shall resume the theory in all its generality, so as to render it applicable to all systems of steam-engines, taking into account the circumstances neglected in our first exposition.

It is well known that in every machine, the effort of the mover first being superior to the resistance, a slow motion is produced, which accelerates gradually till the machine attains a certain velocity which it does not surpass, the mover being incapable of sustaining a greater velocity with the mass it has to move; the machine having once attained this point, which requires but a very little time, the velocity continues the same, and the motion remains uniform during the rest of the work. It is but from this moment, viz., the commencement of uniform motion, that the effects of machines begin to be calculated, and the few minutes during which the velocity regulates itself, or the transitory effects from the velocity null to uniform velocity, are always neglected.

Now in every machine which has attained a uniform motion, the power is strictly in equilibrio with the resistance; for were it greater or less, there

would be acceleration or retardation of motion, which is not the case. In a steam-engine, the force applied by the mover is no other than the pressure of the steam *against the piston* or *in the cylinder*. This pressure then, in the cylinder, is strictly equal to the resistance opposed by the load against the piston.

Consequently, the steam in passing from the boiler into the cylinder changes its pressure, assuming that which represents the resistance to the piston. This principle, of itself explains all the theory of the steam-engine, and in a manner lays its play open.

It becomes, in fact, easy to render an account of what passes in a steam-engine set in motion. The steam confined in the boiler, at a certain degree of pressure, as soon as the regulator or distributing cock is open, rushes into the steam-pipes, and from thence into the cylinders. Arriving in the cylinder, whose area is much greater than that of the pipes, the steam dilates at first, losing proportionally a part of its elastic force; but as the piston is as yet immoveable, and as the steam continues to flow in rapidly, the balance of pressure is soon established between the two vessels; and the piston, urged by all the force of the steam, begins slowly to move. The fly-wheel of the engine, its entire machinery, and the resistance opposed to it, begin then to acquire a small velocity, which accelerates by insensible degrees; and, if at the end of the stroke of the piston, the coming vapor were suddenly withheld, the piston would not stop instantaneously on that account; it would itself be impelled for some time by the effect of the velocity previously communicated to the mass. The result of this is, that at the following stroke the steam finds the piston already slowly receeding, at the moment it impresses thereon a new quantity of motion; which again passes on to the fly-wheel, and to the total mass, where it continues to accumulate. Receiving thus, at every stroke, a new impulse, the piston accelerates its motion by degrees, and, at length, acquires all the velocity the motive power is capable of communicating to it.

During all this time the steam continues to be generated in the boiler with the same rapidity, and to flow into the cylinder; but as the piston acquires a quicker motion and developes a greater volume before the steam, the latter dilates, assuming a lower pressure, till at length, the piston having assumed all the velocity that the steam can impress upon it, with the load that it supports, the pressure of the steam in the cylinder becomes equal to the resistance of the piston, and the motion remains in a state of uniformity, as has been said above.

Thus, from what precedes, we have the pressure which the steam really exercises against the piston; so that if $P'$ represent that pressure per unit of surface, and if $R$ represent the resistance of the load against the piston, divided in like manner per unit of surface, the condition of the uniformity of motion will furnish the first equation of analogy $P' = R$.

This equation establishes the intensity of the effort exerted by the power. Were the case merely one of equilibrium, this determination would suffice; but in a case of motion, not only the intensity of the force is to be considered, but also the velocity with which it is applied. Now, in the case before us, it is evidently the velocity of production of steam in the boiler, which indicates the velocity with which the above force is renewed or applied. To this latter element then of calculation we must recur, in order to obtain a second relation among the data of the problem, comprising the velocity of the motion.

This relation will be furnished by the consideration, that there is necessarily an equality between the quantity of steam produced and the quantity expended, a proposition which is self-evident. If, then, we continue to ex-

press by S the volume of water evaporated in the boiler per unit of time, and effectively transmitted to the cylinder, and by $m$ the ratio of the volume of the steam formed under the pressure P of the boiler, to the volume of water that has produced it, it is clear that $m$S will be the volume of steam formed per unit of time, and under the pressure P, in the boiler. This steam passes into the cylinder and there assumes the pressure P′; but if it be supposed that the steam in this movement preserves its temperature, which as to the engines under consideration, will make but little change in the results, the steam, in passing from the pressure P to the pressure P′, will increase its volume in the inverse ratio of the pressures. Thus, transmitted to the cylinder, the volume $m$S of steam, supplied at each unit of time by the boiler, will become

$$mS\frac{P}{P'}.$$

On the other hand, $v$ being the velocity of the piston and $a$ the area of the cylinder, $av$ will be the volume of steam expended by the cylinder per unit of time. Therefore, on account of the equality necessarily existing between the production and expenditure of steam, we shall have the relation

$$av = mS\frac{P}{P'},$$

which is the second relation sought.

Consequently, by eliminating P′ from these two equations, we have as a definitive analytical relation among the various data of the problem,

$$v = \frac{mS}{a}\cdot\frac{P}{R}.$$

This relation, which is very simple, suffices for the solution of all questions relative to the determining of the effects or the proportions of steam-engines. As we shall develope its terms hereafter, on taking it up in a more general manner, we will leave it for the present under this form, which will render the discussion of it more easy and more clear.

We have, then, the velocity which the piston of an engine will assume under a given resistance R. If, on the contrary, the velocity of the motion be supposed known, and it be required to calculate what resistance the engine may move at that velocity, it will suffice to solve the same equation with reference to R, and we shall have

$$R = \frac{mSP}{av}.$$

Finally, supposing the velocity and the load to be given, and that it be required to know the evaporation proper for the boiler, that the given load may be set in motion at the desired velocity, the value of S must be drawn from the same relation, and it will be

$$S = \frac{avR}{mP}.$$

We limit our deductions here, because, as has been already observed, these three problems are the basis of all problems that can be proposed on steam engines, and that they are sufficient, moreover, to enable us to establish our theory and to compare it with the mode of calculation now in use. But on resuming the same questions with more detail in the following parts of the work, we shall give to the equations their full development, and treat of all the other accessory determinations which occur in problems relative to steam engines.

From what has been stated, it plainly appears that we ground all our theory on these two incontestable facts; 1st, that the engine having attained uniform motion, there is necessarily equilibrium between the power and

the resistance, that is, between the pressure of the steam *in the cylinder*, and the resistance against the piston; which furnishes the first relation $P' = R$. And 2dly, that there is also a necessary equality between the production of the steam and its expenditure, which furnishes the second relation

$$v = \frac{mS}{a} \cdot \frac{P}{P'}.$$

And these two equations suffice for the solution of all the problems.

(To be continued.)

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## NEW CASTLE AND WILMINGTON RAILROAD.

Edward Stavely, Esq., civil engineer, has made a report on the contemplated road between New Castle and Wilmington. The charter for the construction of this road was granted by our Legislature in January last, and the following gentlemen were appointed commissioners:—Thomas P. Cope, Henry Toland, and Matthew Newkirk, of the City of Philadelphia; James Price and Allan Thompson, of the City of Wilmington; and Thomas Stockton, James Booth and James Couper, Jr., of New Castle. The charter enacts that the stock shall be divided into 3000 shares of fifty dollars each.

"The main object," says Mr. Stavely, "for the construction of a railroad from New Castle to Wilmington, appeared in the first instance to be directed to New Castle as a port of refuge for vessels in the winter season."—"Many vessels during the inclmency of the last winter found perfect protection; and amongst them a number of the first class of ships." Mr. Stavely states that "between the 8th of January, and the 1st of April 1839, the following number of vessels took refuge in the harbor of New Castle, viz: 18 ships, 26 brigs, and 52 schooners, exclusive of a number of sloops and other small craft—the aggregate tonnage of which, on a moderate computation, will exceed 20,000 tons." It also affords "a shelter and defence from the immense masses of drift ice on the ebb tide, carried, as they uniformly are, to the opposite shore by the westerly and northwesterly winds which are prevalent in the winter season and being situated on a prominent point of land the ice under the influence of flood tide is necessarily swept to the main channel without effecting the harbor to any extent." These facts, Mr. Stavely considers sufficient evidence that New Castle is entitled to a preference over any other port as a landing place and a harbor, on the whole line of the Delaware river below Philadelphia.

New Castle being thus proven to be an excellent winter harbor, the next consideration is, the safe and speedy transportation of goods, thence to Philadelphia. This is to be accomplished by the erection of a railroad from New Castle to unite with that of the Philadelphia, Wilmington, and Baltimore company at Wilmington—the distance from New Castle to Wilmington being five miles.

Mr. Stavely has made two estimates of the cost of such a road, one amounting to \$80,661; the other to \$60,102 67:—the difference arising from the kinds of rails and wood upon which they may be laid; what is called the I pattern laid on white oak mud sills costing \$31,040; and the flat bar rails on Carolina pine scantling costing 111,916.

From the amount of merchandize and the number of passengers that may be carried on this contemplated road, Mr. Stavely considers it as offering great advantage to those disposed to embark their money in the enterprise. We give an extract on this head from the report:—

"Admitting then, that the sum of \$80,000 will be required to complete

the work, it remains to show how a revenue of ten per centum per annum can be raised to secure a revenue of six per centum to the stockholder for the investment of his capital, and an ample allowance to meet the annual expenses of repairs, agents, etc."

"On inquiry as to the amount of travel between New Castle and Wilmington, taking into consideration their respective vicinities and the city of Philadelphia, with the preference given to the convenience and expedition of a railroad conveyance, it is fair to assume an average of 70 to 80 passengers per day. Taking then, the mean of 75 or 25 cents each, an annual revenue on that item alone will be produced amounting to $5843 74
and as it is impossible to form a correct idea of the amount of transportation of merchandize, but which I am sanguine enough to think will be very great; I allow therefore merely a competency to produce sufficient revenue to substantiate my argument. I therefore admit to the nominal sum of $1156,25

Making a nett total of $8,000 00

—*Wilmington* [*Del.*] *Journal.*

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Statistics in relation to the Norwich and Worcester Railroad.—Length of road $58\frac{1}{2}$ miles, average inclination per mile, 11 feet—maximum inclination per mile, 20 feet.

Distance from Boston via. Worcester to Norwich, 103 miles—distance from Norwich to New York, 125 miles. Time by railroad, steamboat train, from Boston to Norwich, 5 hours—by steamboat from Norwich to New York, 10 hours.

Cotton Mills between Norwich and Worcester, within five miles of the route 75; Woolen Mills 27.

Cotton Mills in New London and Windham counties, containing 106,229 spindles; in Worcester county, 74 Cotton Mills, containing 124,720 spindles, being in these counties 230,949 cotton spindles.

Value of cotton goods manufactured in Worcester county $1,991,024.

Sixty-six Woolen Mills in Worcester county, manufacturing 3,748,852 lbs. wool into cloth, of the value of $3,695,321.

452,310 pairs of Boots, and
2,357,431 pairs Shoes, of the value of $2,791,298.
147,248 Hides, of the value of $387,038.
129,710 Axes, $119,825.
Chairs and Cabinet Furniture, $321,100.
Straw Bonnets $118,971.
Palm Leaf Hats, $411,554.

Total value of articles manufactured in Worcester county more than 12,000,000.

The manufacturers in that county of cotton, wool, hides, paper, iron castings, scythes, axes, cutlery, chairs and cabinet furniture, combs, ploughs, tin ware, and tanneries, number 456.

Amount of sperm oil consumed in woolen mills, 61,329 gallons.

The statistics of towns in Connecticut cannot be accurately ascertained. —*Boston Daily Advertiser.*

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Kite's Safety Beam.—On taking one of the passenger cars off the track of the Columbia railroad, a short time since, it was found that one of the axles was broken. The car had run in that condition four trips between Philadelphia and Harrisburg. It was one of Joseph S. Kite's safety beams and hence no injury resulted.

AMERICAN

**RAILROAD JOURNAL,**

AND

**MECHANICS' MAGAZINE.**

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| **No. 9. Vol. III.** **New Series.** | NOVEMBER 1, 1839. | **Whole No. 345.** **Vol. IX.** |


## AVERY'S ROTARY ENGINE.

The following letter from O. Wilder Esq., Agent of the New York and Michigan mills at Singapore, Michigan, to Mr. John M. Webster, the millwright and engineer who superintended the erection of those mills—gives a statement of much interest to those engaged in the cutting of lumber for market.

The engines used in this mill are "Avery's Rotary," built by Messrs. E. Lynds and Son, of Syracuse N. Y.; and are considered by those who have used them—*when properly put up and superintended*—to be *less* expensive in the first outlay, and *less* expensive for *fuel*, *repairs* and *superintendence* than the piston engine to perform the same amount of business.

Engines of this description, built by the gentlemen above named, or by Mr. Joseph Curtis, of this City, are now in *successful* operation in various parts of the United States—and especially in the Southern States, where they are superintended almost entirely by slaves, who are by most people supposed to have but little capacity for such business. One of them was exhibited at the late Fair of the American Institute in this City, in the most successful operation—driving the numerous machines exhibited there for competition.

SINGAPORE, *Michigan*, June 29th, 1839.

TO MR. JOHN WEBSTER.—SIR—On the first page I hand you an abstract of the amount of lumber sawed at the steam mill of the New York and Michigan company at this place, between the 22nd May and the 26th June by three saws—the mill during that period, has run under many unfavorable circumstances—one of which in particular, viz. bad belts have caused much delay; the material of which the belts were made is not at all suitable for the purpose. Another great cause of delay in sawing has

been the want of the hands—those accustomed to ordinary water mills find themselves quite inexperienced in this.

The mill, including the frame and machinery, having been as you are aware, erected entirely under your direction, it is with much gratification that I can now add my testimony, founded on actual experience, of the great superiority of these engines and machinery over any other kind with which I am acquainted. Yours has certainly been an arduous and laborious duty. Constructed, as these mills were, under very discouraging circumstances, you have nevertheless shown yourself to be fully competent to the undertaking, by the superior manner in which the work has been performed, as well as by the successful operation of the mills, which consist of six upright, and four circular saws, driven by two *Rotary* steam-engines, of Avery's patent built by Messrs. E. Lynds and Son of Syracuse, New York; and I am well satisfied that few, *if any* mills in the United States will compete with them in speed, convenience, or power. The slabs and offals of three saws supply the whole mill with fuel, and furnish power to each engine, to drive two circular, and three upright saws, and also to haul the logs up into the mill. And I must here express my conviction that a steam mill built after this method is, on the whole, to be preferred to any water power with which I am acquainted.

From a trial of the three remaining saws, which have only been in operation this day, I am well satisfied that they will cut as much, if not more than the three which have been some time in operation and have cut the lumber of which I herewith give you an account.

Wishing you every success and prosperity, I am very sincerely yours,

O. WILDER, *Agent of N. Y. and Mich. Com.*

Amount of lumber sawed at the steam saw mill of the New York and Michigan company at Singapore in the State of Michigan between the 22d May and 26th June 1839 inclusive by three saws:—

| | | Saw No. 1. | Saw No. 2. | Saw No. 3. | | Saw No. 1. | Saw No. 2. | Saw No. 3. |
|---|---|---|---|---|---|---|---|---|
| May. | 22 | 1783 | 2366 | 2886 | 10 | 3656 | 2259 | 4116 |
| | 23 | 1775 | 2856 | 2706 | 11 | 4404 | 3011 | 4056 |
| | 24 | 2042 | 3422 | 2982 | 12 | 5205 | 2860 | 4124 |
| | 25 | 1874 | 3250 | 3953 | 13 | 4880 | 3764 | 4301 |
| | 27 | 1695 | 2351 | 3215 | 14 | 5176 | 3832 | 4690 |
| | 28 | 4300 | 3206 | 2472 | 15 | 4897 | 3698 | 3292 |
| | 29 | 3670 | 3985 | 3231 | 17 | 3124 | 2522 | 3295 |
| | 30 | 3546 | 5466 | 5001 | 19 | 2765 | 3659 | 2480 |
| | 31 | 3226 | 5093 | 4413 | 20 | 2931 | 2373 | 2282 |
| June. | 4 | 3933 | 3869 | 5378 | 21 | 4482 | 3664 | 3203 |
| | 5 | 4170 | 3170 | 3696 | 22 | 4776 | 3147 | 4146 |
| | 6 | 5111 | 4357 | 4927 | 24 | 4121 | 4237 | 4434 |
| | 7 | 4802 | 2939 | 4144 | 25 | 4179 | 3573 | 5468 |
| | 8 | 5006 | 3445 | 4479 | 26 | 4026 | 3097 | 3466 |
| | | Total | | | | 105,555 | 95,461 | 106,845 |

**RECAPITULATION.**

| | | |
|---|---|---|
| Saw No. | 1 | 105,555 |
| " | 2 | 95,461 |
| " | 3 | 106,845 |
| Total | | 307,861 |

N. B.—Saws No. 4, 5 and 6 have only run one day, they are fully able to saw as much, if not more than saws No. 1, 2 and 3. O. W.

Total amount of lumber sawed in twenty-eight days sawing three hundred and seven thousand eight hundred and sixty-one feet.

*Singapore*, 29*th June*, 1839

We submit the following document to our readers, and would recommend the more frequent use of condensed and popular views of important railroad documents which, from their very nature, are not to be attempted by any one but the engineer himself. The importance of the Louisville, Charleston and Cincinnati railroad is such, that this paper of Major M'Niel cannot fail to receive attention.

ENGINEERS OFFICE L., C. AND C. R. R. CO., GREENVILLE, S. C., OCTOBER, 14, 1839.

*To the President and Directors of the Company:—*

GENTLEMEN:—Recurring to the extended operations of the Engineer department throughout the last three years, I am reminded, from the obvious want of knowledge of the subject, (apparent, as I think, in the nature of recent discussions at the annual meeting of stockholders at Ashville,) that, instead of expecting a general perusal of the voluminous documents reciting those operations and their results, it probably may subserve the interests of the stockholders and the public generally, if I summarily recite, as I now propose some of the more important facts which have a bearing on the enterprise committed to your management. My object will be, as far as in my power, to enable every one to form his own opinion of the real prospects of the Company—so far as may be deduced from a statement of the probable cost of constructing the railroad in its future progress to and beyond Columbia; and while I do not expect to be unerringly exact, I am willing it be recollected that on mature deliberation, I am of opinion that the following estimate will rather exhibit the *maximum* than the probable cost of the work.

It is well to premise, however, that of course the *cost* must mainly depend on the *plan* of the work; and as "entire efficiency for the important object for which the railroad is designed" will be regarded as indispensable to my plan, I shall first briefly state the few particulars, affecting *cost*, in which the several plans would differ.

1. The plan of that portion of the main trunk of the Louisville, Cincinnati and Charleston railroad, diverging from the Hamburg railroad at Branchville, and extending to Columbia, a distance of 66 miles, contemplates a road-bed of sufficient width (that of embankments being 25 feet, and of excavations 30 feet and upwards, in proportion to the depths of cuts,) for two tracks, or in other words for a double railway: the superstructure, or *railway*, to be constructed in the most approved and durable manner, with a heavy iron rail, of the form of an *inverted* T, weighing, say 56 pounds per lineal yard, and of sufficient strength to dispense with a continuous support, being merely *tied* together by transverse pieces, at intervals of three feet.

The reasons in favour of this plan were deemed to be cogent, and will be found as well in the *charter* which determined the width of road-bed for a *double track*, as in my 1*st Annual Report*, pages 45 to 50, which induced the adoption of the rail described.

2. The foregoing plan may be advantageously modified in the progress of the road above Columbia, to a width sufficient for but one track, with requisite passing places, (the embankments being not less than 16 feet width and the excavations in order to provide drainage, not less than 22 feet,) retaining the same description of railway, with the permanent iron rail.

The first question is, will this plan be efficient? I think it will—for, generally speaking, two tracks are not indispensable to the *accommodation of trade* (and in this case I am sure will not be,) but rather for the *securi-*

*ty of trains passing* in opposite directions on serpentine roads, where the vision being frequently obstructed, two tracks are desireable—whereas our road is remarkable for its extent of straight lines, and the absence of abrupt curvatures. When necessary, the road-bed, moreover, can be widened, and meanwhile its reduced width would result in a saving of about one-fourth the first outlay estimated for a double road-bed.

3. It admits of a still further modification, reducing as before, the width of road-bed, and substituting a light iron rail, or bar, (similar to that used on the railroads in Georgia, and in most other States except Massachusetts,) requiring a continuous support on wood, as practised on the Hamburg and other similar roads.

This plan is objectionable because of the perishable nature of the railway, and the consequent annual outlay for repairs; nevertheless, such a railway as is contemplated may be constructed at an average not exceeding $5000 per mile (its cost varying with locality,) at least equal in efficiency to any of our southern railroads, and resulting thereby in a saving in first cost of about $5000 per mile less than by the second plan described, which, as above stated, would also reduce the first cost by either the second or third plan, one-fourth the total cost of graduation on the plan originally proposed and adopted.

Having made these explanations, I proceed to a statement of the probable cost of the railroad, on the foregoing plans, from Branchville to Knoxville.

1. As per plan No. 1:—

| | |
|---|---|
| Branchville to Columbia, distance 66 miles, cost, | $1,600,000 |
| Thence by probable route to the North Carolina line, 114 miles, | 2,750,000 |
| Thence to Butt Mountain Gap (summit of the Alleghany) 23 miles | 1,250,000 |
| Thence to the boundary line between North Carolina and Tennessee, 74 miles, | 1,600,000 |
| Thence to Knoxville, 70 miles, | 1,400,000 |
| Total cost by first plan, with a double road-bed, and a permanent iron rail, | $8,600,000 |

| | |
|---|---|
| Extending through South Carolina 180 miles, and costing | 4,350,000 |
| Extending through North Carolina 97 miles and costing | 2,850,000 |
| Extending through Tennessee 70 miles, and costing | 1,400,000 |
| Total as above, | $8,600,000 |

Before I proceed to state the probable cost by either of the other plans, it is well to remind you that (in consequence of the progress already made between Branchville and Columbia) no material diminution can be made in the cost of the *road-bed* between those points; and that as the heavy iron inverted T rail has already been ordered, and is daily expected, sufficient for about twenty miles of the road, a reduction even in the cost of the *railway* to Columbia, could only obtain for the remaining 46 miles—on which suppositions I proceed.

2. As per plan No 2, with a single road-bed, (above Columbia,) and a permanent iron railway.

| | |
|---|---|
| From Branchville to Columbia, double road-bed, | $1,600,000 |
| Thence to the North Carolina line, single, | 2,350,000 |
| Thence to Butt Mountain Gap, single, | 1,000,000 |
| Thence to the Tennessee line. single, | 1,385,000 |
| Thence to the city of Knoxville, single, | 1,225,000 |
| Total cost by the above plan, | $7,560,000 |

| | |
|---|---|
| The coast of that portion in South Carolina being | $3,950,000 |
| The cost of that portion in North Carolina being | 2,386,000 |
| The cost of that portion in Tennessee being | 1,225,000 |
| The whole cost being | $7,560,000 |

3. As per plan No. 3, substituting a lighter iron rail requiring a continuous support, or for a railway similar and equal to those in Georgia and other southern States.

| | |
|---|---|
| From Branchville to Columbia, | $1,400,000 |
| Thence to the North Carolina line, | 1,780,000 |
| Thence to the Butt Mountain Gap, | 885,000 |
| Thence to the Tennessee line, | 1,015,000 |
| Thence to the city of Knoxville, | 975,000 |
| Total cost by the 3d plan, | $6,055,000 |
| The cost of that portion in South Carolina being | 3,180,000 |
| The cost of that portion in North Carolina being | 1,900,000 |
| The cost of that portion in Tennessee being | 975,000 |

| | |
|---|---|
| The average cost per mile would be, then, by plan No. 1, with a double road-bed and permanent rail, | $24,784 |
| By plan No. 2, single road-bed above Columbia, and permanent rail, | 21,787 |
| By plan No 3, single road-bed and flat rail, | 17,450 |

or the average cost per mile, if even built on the most expensive plan, (as regards first outlay,) will but little exceed what was stated at the annual meeting to have been the average cost of railroads in the United States, (to wit, $20,000 per mile;) while from my own personal knowledge I do know that similarly constructed works, the railroads which radiate from Boston and perforate the Bay State in almost its remotest corners, cost on an average upwards of $40,000 per mile (some of them nearly $60,000,) which *is* in proof of what was so much dwelt on at Ashville, that "*in the south we have advantages in formation of country, growth of materials, etc., by which we should be enabled to build roads cheaper than at the north.*"—The offset to this is, that whenever mechanical skill is to be brought in requisition, they having more of it, because of more constant demand for it, can more easily command it, and at a cheaper rate. Nevertheless, under all the circumstances if the means be afforded it seems that we may even traverse the Alleghany mountains *through the Carolinas* connect together the south with the west, make as it were a central navigable stream through South Carolina, afford an outlet from Western North Carolina, *redeem the faith* of the projectors of our great enterprise, at less than it was deemed proper to expend—calculating, as they (the Yankees) did, the cost—to promote the mere convenience of the travelling public, and that communion resulting simply from intercourse among themselves. True, they have reaped a golden harvest pecuniarily. I do not mean to say that we shall; and by no means that we shall not. But they by no means expected so adequate a return on their invested capital. Trade and travel have far surpassed (as in all similar cases they have) their most sanguine expectations. And why should there, in our enterprise prove an exception? On this subject I will merely add that those most expensive railroads (so far as first cost may characterise them as such) have yielded, from their first "opening" to the public, from 6 to 9 per cent., and some of them 10 per cent. And recuring once more to assertions in the convention at Ashville, it shows how

fallacious would be the argument (if such it could be termed) that "*inasmuch as—according to Chev. de Gerstner—the average cost of railroads has been* $20,000 *per mile, and the average income* 5 *per cent;* THEREFORE, *wherever the cost exceeds the average, the income must be proportionably diminished!*" As well might it be inferred, that because our most expensive railroads (in first cost) yield more than the average—nearly the double of it—*therefore,* the more expensive their construction the more profitable ultimately!

The truth is this—railroads have proved profitable from a cause indespensable to the profitableness of all similar works, to wit:—Their (in the extended sense of the word,) economical management, under the administration of but a very limited number of agents, adequately recompensed, with full authority, under the board of directors, held to a strict accountability, and *judged by their works.* It is not a bad criterion, in such a case to compare the outlay with the income, the difference being the nett reveue; and I hazard the opinion that the latter is more generally the result of a judicious construction of the road, (avoiding as far as means will permit, the necessity of constant renewals and repairs, which consume the income,) and an economical subsequent management of the work, than of the greater or less amount of trade; for, without adducing instances, it is a well known fact, that cases have occurred where, large as the income has been, and gradually and rapidly increasing, that the expenditures have increased in a greater ratio, and absorbed even more than the whole receipts.

Returning to the estimates of cost, I respectfully submit, if it be not rather expedient that a reduction in cost be effected by a diminished width of road-bed (*retaining the utmost efficiency of the whole work*) than by the substitution of a lighter and more perishable railway; and in this view of the case I recommend to your adoption plan No. 2, rather than plan No. 3, by which the cost within the several States will appear, as herein before stated, materially less than heretofore expected.

And as there seemed to have been at Ashville some misapprehension of the estimates on which were based contracts for the work in progress toward Columbia, so far obscuring, I think, the subject that possibly some may still be under the impression that the estimates were extravagant, and the contracts entered into by the board equally so—it may be well to state that pains were taken to give all the elements on which the estimates were based—(that in so doing, we "might perchance disseminate, as was desirable, useful information to those interested in the subject, and especially to such as should in the further prosecution of the work compete for contracts;") that those estimates have stood the ordeal of critical analysis of competent engineers, (practically conversant with their profession;) and what is most material, experience, in the progress of the work, has fully satisfied me that they are not as liberal as they should have been and were intended to be; for I much fear the contractors will scarcely in any case be more than indemnified for their actual expenses, to say nothing of what they are justly entitled to—some compensation at least, beyond their expenses.

The contract prices on the Hamburg railroad having been cited, (I suppose as a just criterion,) I will merely state that it is demonstrable that *yard for yard,* and in every way that they can be compared, (for the two structures are as dissimilar as a ship and a house) it has cost more than the Louisville, Cincinnati and Charleston railroad so far. The latter, at any rate, does not exceed the cost of the former, $1000 per mile, graded as it is for a double track, (the former being graded to a width of but 13 feet for a single track, and generally nearly coincident with the natural surface) while the

Louisville, Cincinnati and Charleston railroad, moreover, in its direction from Orangeburgh to and across the Congaree river, lies transverse to the intervening ridges and valleys; including too, an expensive viaduct and much *masonry*—of the latter of which there is none on the Hamburg railroad. It is to be assumed, therefore, that so far as the cost of construction of the Louisville, Cincinnati and Charleston railroad thus far may be judged by comparison with that of the Hamburg railroad, (and I add with that of any other railroad ever built) it will not be disparaged on the score of cheapness and economy and ultimate efficiency. Referring to the last annual report for information on the progress and condition of that portion of it now under contract, I will merely repeat that it is very practicable to complete and put in profitable use the whole of it to Columbia within the next ensuing year—and, as stated in my first annual report, "if vigorous operations be persevered in, I am sanguine in the belief they will enable us to triumph over every obstacle, and as early as the year 1846, to celebrate the entire completion of this stupendous enterprise"—connecting the southern Atlantic sea board with the west, without reference to a Lexington, a Louisville, or any other *place*, but rather to whichever may be its most eligible point on the Ohio or the Mississippi river.

It remains for me to add a few words on the much talked of expenditures of the engineer department. Unquestionably they have been very large; but by no means disproportionate to our greatly extended operations, beyond any similar which have elsewhere been attempted in the same limited period of time. For instance, in the short space of the first six months prior to the 1st annual meeting, two years since, investigations by recognizance and experimental surveys, were required to determine not only the practicability of the whole project, but the relative merits of various routes, which in their total modifications amounted in the aggregate to quite minute surveys for about 2000 miles in extent! This of course required a large force and an outlay for instruments (when the demand for them generally was very great, and their price proportionably great) beyond our future wants. A rigid investigation however, by a committee of the stockholders, attested the industry of the several brigades, and the economy with which the affairs of the department have been administered up to that time; and similar testimony is on record from committees of directors, who from time to time have in the usual vigilance of the board, been appointed with a similar design. In fact I am bound to state, that in no instance has there been any one employed whose services could advantageously have been dispensed with; that the greatest amount of duty compatible with its due discharge, has uniformly been assigned to each; that a compensation pecuniarily, none has received equivalent to the value of services rendered; and lastly, that each and all who have been employedin the service have done their duty, to the entire satisfaction of the chief engineer, (and I think I am fully authorized to add, to that of our late lamented president and of the board of directors,) and that they may well be as they are, content to be judged *by their works*, rather than any other testimonial of merit.

Appreciated, however, as all now in the service of the company are, personally and professionally, and reluctant as I am to dissolve with either, even temporarily, a connection such as has existed—a re-organization of the engineer department, "on a scale proportionate to reduced operations," must, for a time at least, recommend the services of some to be dispensed with. A great source of unavoidable expense heretofore (*extravagance*, possibly some have thought it, although I confess I do not think unavoidable expenditure necessarily implies extravagance,) will have already terminated in the completion of the surveys to such extent that the engineer

department may be so reduced and re-organized, retaining its efficiency, that the cost probably will not much, if any, exceed the sum of $16,000 per annum. For my own part I cheerfully propose the voluntary relinquishment of my own salary hereafter, to whatever extent may be desirable. My services I feel it due to the work and to myself, therefore, yet awhile to continue to render. In fine, gentlemen, in whatever I can to the extent of my ability—I trust I shall not be found wanting in the most cordial co-operation with you in the discharge of your arduous (I was about to say most *onerous*) duties; limiting our expenditures to the *minimum* consistent with a wise economy and enforcing the most economical administration in such affairs as may, under your instructions, depend on me.

I have said that my personal services, I am aware, cannot at once be dispensed with; it is the result of the late recent melancholy occurrence in the death of our President, which has, for a time, devolved unexpected duties on me, requiring *continuous* service on my part: else I should have at once proposed, what I hope soon may be accomplished, that my future relation to the work should rather be that of a consulting engineer, (visiting the road periodically, or as exigencies might require) than as I am and have beenfor the most part confined to it. Impelled as I was when I first yielded toyour flattering, because unanimous and unsolicited invitation, to accept the distinguished post I have the honor to occupy, to wit, because of your impression that I could be useful to your great enterprise, and my hope that I might fulfil your expectation, together with an earnest desire on my part to further, as far as in me lay, the more particular interests of my native section of country—so shall I most cheerfully return to you the responsible trust confided to me, whenever a suitable occasion shall present to enable me consistently to do so.

Repectfully submitted by

WM. GIBBES M'NEIL.

*Chief Engineer, L. C., & C. R. R.*

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TO JOHN DOVOR AND WILLIAM JONES OF LONDON, FOR THEIR INVENTION OF IMPROVEMETS IN FILTERING FLUIDS.

This invention relates to a mode of clarifying such fluids as require such a process so as to render them fit for use, and consists in causing such fluids to pass through the skins of animals by the aid of pressure, by which means a high degree of purification takes place.

The skins employed for this purpose are sheep skins, in preference to others, although the skins of other animals will answer the purpose. These skins should not be tanned, but are to have the wool cut off, and are to be treated in the same manner as if they were going to be tanned, as will be readily understood by tanners. The skins, when prepared, must be laid on some supporting surface, such as hair cloth, when placed in the filter, as the strain or pressure to which they would be subjected would otherwise quickly injure the texture of the skins.

The Patentee says, in conclusion, that the fluids to be clarified or filtered may be forced upwards through the skins, if thought preferable: and they claim as their invention, "the application of the skins of animals as a filtering medium to filtering apparatus or machines for clarifying or purifying such fluids as require that process."

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LAUNCH OF THE EAST INDIA COMPANIE'S ARMED STEAMER SESOSTRIS.—The launch of this beautiful vessel took place on Tuesday from the dock-yard of Mr. Pitcher, at Northfleet. The Sesostris is one of a class built by order of the East India company, for the express purpose of

protecting their trade in the Indian seas. She is a magnificent vessel, of the highest order of naval architecture, and is altogether worthy of the important post, assigned to her.—*English paper.*

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### RAILWAY SOCIETY.

We find in the Civil Engineer and Architects' Journal, for April, a notice of a meeting of delegates from the principal Railway Companies in Great Britain, "for the purpose of considering the propriety of forming a Society for promoting, and advancing the scientific improvement of railways, throughout the kingdom; and for protecting generally the interests of railroad proprietors." The idea is a good one—and we recommend the subject to the same class in this country, as there can now, we are fully persuaded be little danger in asserting the opinion that railroads are to become the *leading* medium of *transportation* as well as of travel—and will of course involve the interests of more people than any other branch of business except agriculture.

A private meeting, very numerously attended by the deputations from most of the leading railway companies, was held on Saturday last, at the chambers of Messrs. Burke and Venables, in Parliament St., for the purpose of considering the propriety of forming a society for promoting and advancing the scientific improvement of railways throughout the kingdom, and for protecting generally the interests of railway proprietors.

Mr. George Carr Glyn, the chairman of the London and Brighton and North Midland railway companies, was called to the chair, and opened the proceedings by adverting to the great and manifest importance of the proposed society, as affording a means of bringing the united experience and influence of the principal persons connected with railways to bear upon all questions which may arise respecting them.

The honorable chairman further alluded to the very great ignorance which exists among many, even at this day, on the subject of railways, and the consequent prejudices which prevail against them, and pointed out the great advisability of having some regularly organized association which would be looked up to as an authority on all subjects in which their interests were involved.

The meeting was subsequently addressed by several other gentlemen present, who all concurred in the importance of the proposed association, and dwelt on the advisability of forming, at its outset, a collection of maps, reports, models, and other scientific and statistical details relating to railways, which should be accessible to the several members of the society, and which would in time become a most valuable and interesting museum of reference on matters connected with railways.

Some discussion took place as to the amount of the subscriptions, and the name to be given to the proposed association, viz: whether it should be called the "Railway Society," or the "Railway Institute;" but eventually this, with all other matters of detail, was left to a committee of management formed of some of the directors of the principal railway companies present, who were empowered to add to their number, if they should see fit.

Resolutions, embodying the substance of the foregoing remarks, were unanimously passed, and the several persons present, having enrolled their names as the first members of the society, the meeting separated.

## BLASTING BY THE AID OF GALVANISM.—INTERESTING EXPERIMENTS ON BLASTING AT CRAIGLEITH QUARRY.

On Tuesday, 26th of March last, a large party of gentlemen assembled in Craigleith Quarry, to witness some experiments on blasting by means of galvanism, which were made at the request of the directors of the Highland and Agricultural Society of Scotland by Martyn Roberts, Esq.

It has long been known that the ignition of gunpowder can be very effectually produced by the application of the electric fluid; but Mr. Roberts has succeeded in producing an apparatus for this purpose, which is simple in its structure, very portable, and which, above all, is easily managed.—He has also, in the application of this apparatus to blasting rocks, introduced various modifications of its arrangements, and effected great improvements in the mode of charging.

The apparatus consists of a small trough, about a foot in length, and four inches square on the end, and a battery containing ten pairs of plates.—Along the battery runs a bar upon which a tin disc slides freely. This disc, when drawn to the end of the bar, touches another disc, and thus completes the connexion between the opposite poles of the battery. To prevent accidents, the sliding disc is kept in the middle of the bar by means of a spring of coiled wire; and it is impossible to put the battery in action although sunk in the trough without shifting the plate along the bar to the opposite end of the trough. The copper wires which convey the electric fluid to the gunpowder are kept separate during their whole course by a sheath of cotton thread, which is wrapped closely round them in the same manner as in the strings of a guitar, or as in the wire which stiffens the rim of a lady's bonnet. At their termination these wires are bent outwards and their extremities are connected by means of a fine steel wire half an inch long, so as to form a small triangle, like the Greek capital *delta.* This triangular end is inserted into a small tin cartridge, and ignition of the powder contained in the cartridge is produced by the deflagration of the steel wire which connects the ends of the two copper wires. So rapid is the progress of the electric fluid, that it is impossible to measure the interval of time which elapses between the action at the trough and the explosion of the cartridge. The cost of this apparatus is only about fifteen shillings; and the price of the materials required for the solution is such, that a shilling will cover the expense of keeping the trough in a working state for months. The copper wire which, if properly shielded, may last for years, costs about one farthing for each yard. In applying this apparatus to blasting, Mr. Roberts makes the following arrangements:—In regard to the mode of charging, which is perhaps the most important peculiarity of his method, he leaves a space of about one foot, containing atmospheric air, above and below the gunpowder; and thus obtains, over and above the effect of the gunpowder, all the power which the sudden increase of its volume produces; and thus the same effect is obtained from a smaller charge. He also inserts the tin cartridge into the heart of the charge of powder, and as the cartridge explodes at both ends, the gunpowder is much more instantaneously ignited. Lastly, in tamping, no vent-hole is left, as in the common system, by the withdrawing of the needle; but the tamping is pressed closely round the wire which conveys the electric fluid from the trough to the cartridge. When the tamping is completed, the battery is plunged into the trough which is at the distance of 40 feet from the bore-hole and may of course be removed as far as may seem desirable, by giving a small increase to the power of the battery if required, which is easily effected by adding a pair of plates. The spring of coiled wire still keep-

ing the tin disc in the middle of the bar, there is no risk of an unexpected explosion, a danger which occasionally happens by the too rapid ignition of a train or fuze in the common method of blasting. Every one having retired, a person stationed at any safe distance, pulls a string, which makes the tin disc pass along the bar, and the instant the connection of the opposite poles of the battery is established, the explosion takes place. We shall briefly detail the chief advantage of this new system of blasting, which we conceive to be as follows:—

1. Freedom from the dangers which always attend blasting is obtained from various causes. In the common system, the fuze or train must be fixed at or very near the bore-hole, long trains being expensive and uncertain in their action; and accidents, from the too rapid burning of the fuze, are unfortunately very common. But in Mr. Roberts' system, the person who pulls the string which puts the battery in action, may be stationed at any convenient distance. In the present system, perhaps the most common source of accident is the withdrawing of the needle; and this is completely avoided in Mr. Roberts' plan. Lastly, there is less chance of failure, and when failure does occur, the bore-hole may be at once approached without risk of accident, as the moment the string is slackened, the action of the battery ceases.

2. The next advantage is, the great facility which this mode gives for blasting under water. This is one of the most inconvenient, expensive, and uncertain of all engineering operations. It involves much trouble and expense in laying hoses for the train or fuze, which are destroyed every time; and after all, there are, perhaps, three failures out of ten trials. All this is avoided by Mr. Roberts' system, which is as efficient under water as above it, and involves not one farthing of loss under water more than on land.

3. The great advantage of a much more rapid ignition of the gunpowder, which encloses the cartridge on all sides, and receives the action of the flame over the greater part of its surface at the same instant, gives the new system a great superiority. This is a most important element in the effect of the charge, as its full force is thus secured. In the present method, on the other hand, the powder is fired from the top, and when hard rammed frequently burns away in a series of smaller explosions, producing successive shocks, separated, it is true, by imperceptible intervals of time, but yet producing an effect greatly less powerful than they could have done if concentrated in one shock, so as to act simultaneously.

4. There is absolutely no vent-hole in the mode of tamping pursued by Mr. Roberts, which mode cannot be applied to the present system of blasting. This is an important gain, the vent-hole being a decided loss of power, which is well known to gunners, and to counteract which, the Turks are in the habit of covering the touch-hole of their guns with a bag of sand the moment the priming is fired.

5. The advantage of enclosing a column of atmospheric air, as practised by Mr. Roberts, is obvious, for the force exerted during its expansion is added to that of the gunpowder itself. What that expansion may be it is difficult to tell, as we have no good means of ascertaining the increase of temperature which accompanies the explosion of gunpowder: but as the volume of atmospheric air is doubled for every increase of temperature of 450 degrees of Fahrenheit, the force produced by the expansion of the enclosed column of atmospheric air must form an important addition to the effect of the gunpowder.

6. It follows necessarily from what has been said above, that the combined effects of the instantaneous ignition of the gunpowder, the absence of

all vent-holes, and the expansion of the enclosed column of atmospheric air must cause a much greater effect than the explosion of the powder alone in the common system can produce, and consequently that a great economy in the article of gunpowder must result. This is a far more important item in the expense of quarrying and rock excavation than is generally imagined by those who are unacquainted with such works. In the excavation for the Philadelphia water works, for example, nearly 3000*l.* were expended in gunpowder, and at the rock-cutting for the new approach to Edinburgh, by the Calton hill, 1000*l.* were spent in this item alone. In granite quarries the powder for a single shot often costs 3*l.* If the method of Mr. Roberts produces a saving of about two-thirds of the quantity of gunpowder required for blasting, as would appear from the experiments which were made on Tuesday, some idea may be formed of the great economy which would follow on the adoption of the new system.

7. The system of Mr. Roberts makes the simultaneous firing of several blasts easily practised; and in many situations where the removal of the men to a place of safety is difficult, this is an important advantage.

The following details of the experiments made on Tues day, by Mr. Roberts, are chiefly taken from the notes made by Mr. Inverarity, of the Madras engineers.

No. 1. Bore of hole, 2½ inches; depth, 3 feet; powder used, 2 pounds; column of air left in the bore, only 3 inches in height; line of least resistance, 18 inches: the effect was good; the rock was much splintered, and some fragments were thrown into the air.

No. 2. Bore of hole, 2¾ inches; depth of hole, 8 feet; half the usual charge of powder used; column of air left, 2 feet in height; effect enormous;—immense mass moved; few fragments thrown into the air; deep rents all round, and large masses loosened.

No. 3. Bore of hole, 2¾ inches; depth, 6 feet; two-thirds of the usual charge of powder; column of air left, 18 inches in height; few fragments thrown into the air, but large masses loosened.

No. 4. Dimensions of hole same as the last; charge of powder, less than one-half the usual quantity; column of air left, 2 feet in height; effect very good indeed; much rock loosened; no fragments thrown into the air.

No. 5. Bore of hole, 2¾ inches; charge of powder, two-thirds of the common charge; column of air left, two feet in height; effect excellent; about 300 tons of rock supposed to be torn away; much rock loosened, and deep rents observable: no fragments thrown up.

Nos. 6 and 7. No account of bore-hole taken; powder, one quarter of the usual charge; effect of both was good.

No. 8. Experiment under water. In this experiment, five pounds of powder were put into a bladder and sunk to the depth of ten feet under the surface of the water, in a deserted quarry west of Craigleith. The string was drawn, and the effect was instantaneous; a dull red globe of light, caused by the explosion of the powder under water, was observed, and immediately there followed a considerable shock which was sinsibly felt on the margin of the pool, at the distance of about 100 yards from the explosion; a mass of water about 10 feet in diameter, and 2 feet in height shaped like a flat dome, rose above the surface of the pool, and immediately after it disappeared, the mud and burned powder boiled up from below like a cauldron.

The directors of the Highland Society in attendance, and all present were highly pleased with the complete success of the experiments.—*Edenburgh Advertiser.*

Railway Signals.—The annexed statement from Roscoe's work on the London and Birmingham railway, describes a system of signals, to prevent accidents on railroads—and we recommend it to the directors of railroads in this country, and urge upon them the adoption of this or *some other plan* to prevent the occurrence of accidents, which are becoming quite too common—and are often used against the "railroad system." We do not however admit for a moment that in proportion to the number of passengers, and business, and experience in their use, a greater number of accidents occur on railroads, than by other modes—yet as accidents *do often occur*, it is the imperative duty of the directors of railroads to adopt a thorough system of police to prevent them.

Every station of the Birmingham railway is furnished with an alarum, to give notice of the approach of each train, and to summon the whole of the men to their appointed places. These alarums are so constructed, that a weight is wound up after they have performed their office which prepares them to perform it again. On seeing the forthcoming train has reached the proper spot, the policeman stationed at them pulls a trigger, and the weight begins to descend, ringing a loud gong-shaped bell by means of internal machinery. Bells are also hung so as, in a few seconds, to collect together the whole of the men belonging to the station for any required purpose.

The police are placed along the line at distances varying from one to three miles, according as local circumstances rendered it necessary. Each man has his beat and duties defined, and is provided with two singal flags, one of which is red and the other white; the white flag is held out when no obstruction exists: and, on the contrary, the red flag indicates that there is danger, and that the train must not pass the signal till it is ascertained that the cause of danger is removed.

Each policeman, also, is furnished with a revolving signal lamp, to be used after dark: which shows, at the will of the holder, a white light when the line is clear; a green one when it is necessary to use caution, and the speed of the train be diminished; and a red light, to intimate the necessity of immediately stopping.

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The following statement in relation to the first years performance of the Steam Ship "Great Western" must be highly satisfactory to the early friends of Atlantic steam navigation.

Great Western Steam Ship.—A half yearly general meeting of the proprietors was held in Prince's St., Bristol, last week. Mr. Maze took the chair. Mr. Claxton read the report, which stated that the company's first ship had disproved all unfavorable auguries, and promptly rewarded the enterprise of the projectors. It was impossible to speak too highly of the qualities of the Great Western steam ship; after having run 35,000 nautical miles, and encountered 36 days of heavy gales, her seams required no caulking, and when she was docked she did not show a wrinkle in her copper. The average of her passages out was 15½ days, and home 13 days; the shortest passage out was 14½ days, and the shortest home 12¼. About 1000 passengers had gone in the ship. After alluding to the great expense necessary to combine speed, security and enjoyment, it expressed a hope that through the liberality of the American Congress the duty of 2d. per bushel on coals would be given up, and thus a saving of

nearly 1,000*l.* a year would be effected. The company have decided on constructing their next vessel of iron, for which the preparations are far advanced. It appeared from the statement of accounts, that after paying 2,000*l.* for additions to the ship, and insurance to October next, 1,500*l.* for goods damaged in the hurricanes in October last, and upwards of 2,000*l.* being set apart for a reserve fund, there remained from the profits sufficient for a dividend of 5 per cent., making, with the former one of 4 per cent., 9 per cent. for the year The report was unanimously adopted.

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## WESTMINSTER BRIDGE.

We before noticed a commencement of the works for the repair of Westminster bridge, in a former number; a dam has since been completed round two of the piers on the Westminster side, and a beginning made with the piling round them.

The great extent of the coffer dam (being no less than 500 feet in circumference,) as also the difficulty experienced in driving the piles through a hard crust of gravel which overlays the clay at this place, and the care that must have been taken in doing the work, by so effectually shutting out the water, makes it appear to us truly astonishing that so much has been done in the short period of eight months, especially as all works of this nature depend so very much upon the weather and tides.

Great credit is due to the parties in charge of the work; and, if we may judge from the earnest manner in which they are proceeding, the public will have no cause again to complain of the tardy progress which hitherto marked every thing connected with this bridge.

Neither can we omit to state, that upon our late visit, the gratification we experienced in witnessing the very dry state of the work, and although the level at which they are now proceeding is several feet below the bed of the river, there was not the slightest leakage; and we understand that the same has been the case since the completion of the dam.

The plan of operation for protecting the foundation of the piers, from being undermined by the wash of the river, is, by surrounding the caisson upon which the pier is built with sheet piling, driven as close as it is possible to bring wood and wood together. The piles are driven fourteen feet into the solid ground below the bottom of the stone work; they are 12 inches thick, and the space between the pier and the piles is afterwards filled in solid with concrete, upon which masonry of square stones of large dimensions is laid, the top of the piles being dressed off to a fair and uniform line, and further secured with a strong band or wailing of timber, encircling the whole tie, which is held in its place by iron caisson bars, firmly fixed to the main timbers of the caisson.

By this plan very little obstruction will be offered to the current, should any further increase of depth in the river take place, and from what we saw of the care taken to make the joints close, there will not be, in our opinion, the slightest apprehension for the safety of the bridge, should the river deepen three times as much as it has since the removal of London bridge—a circumstance very unlikely to happen.

In comparing this method of work with endeavoring to accomplish the same object by diving bells (which was the plan, till lately, followed at this bridge,) there cannot be a question which is the best; in one, all is done in the dark, or otherwise hid from view; while in the other it is seen as the work progresses; in truth, the last is the only proper course.—*Civil Eng. and Architects' Journal.*

BALTIMORE AND OHIO RAILROAD.—It is gratifying to learn that this great *pioneer* work is to be continued. By the annexed paragraph from the Baltimore Patriot, we learn that the president of the company, the Hon. Louis M'Lane, has been successful in negotiating Maryland State Stock, to an amount which will enable the company to continue, their operations, even in these difficult times—and of course until they reach the Ohio river an ultimate result, which we have never for a moment doubted—however much we have regreted its delay.

"Among the passengers in the Great Western is the Hon. Louis M'Lane, president of the Baltimore and Ohio railroad company, who visited England for the purpose of disposing of the Maryland State bonds given to that company in payment of its stock subscription of $3,000,000. We are gratified to learn that he has succeeded in making such an arrangement in London as, under the peculiar circumstances of the money market there, is considered quite satisfactory, and the effect of which will be to enable the company to continue the prosecution of its work westward with vigor.

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*Iron Ship.*—The largest iron sailing ship in the world is now building in Messrs. J. Ronald and Co.'s yard, Footdee, Aberdeen. This stupendous vessel is of the following dimensions:—Length of keel, 130 feet; breadth of frame, 30 feet; depth of hold, 20 feet; length over all, 137 feet; tons register, 537. Judging from her appearance, she is a beautiful model, and will carry an immense cargo on a small draught of water. She is intended for a company in Liverpool.—*Aberdeen Herald.*

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### "PROGRESS OF RAILWAYS" IN EUROPE.

Under this head we find in the "Civil Engineer and Architects' Journal" for July last, the following statements in relation to the progress of Railways in England; many others of much interest might be added, but these are sufficient to show that the progress of the system is *onward;* and it is also gratifying to learn that these numerous important works, so creditable to the companies by which they are constructed, are most, if not all of them, yielding a liberal return to the share holders upon their investment.

The Liverpool and Manchester Road, it will be seen by an extract from their last report annexed, continues to pay a *semi-annual* dividend of 4½ per cent. upon its immense cost.

*Opening of the Eastern Counties Railway.*—This railway was opened on Tuesday, the 18th ultimo. A large concourse of persons assembled at the temporary station, Devonshire street, Mile-end, to witness the departure of the first train on this line of railroad. The line commences at Shoreditch, on a viaduct about twenty-one feet above the level of the ground, up to which extensive and commodious carriage approaches will be made. At the commencement of the viaduct it is proposed to erect the London station, which will be of commensurate extent with the existing traffic. In it are several bridges, the arches of which are faced with stone, which gives them a handsome and imposing character, especially the bridge over Devonshire street, the arch of which rises less, for the span, than we have observed on any other line of railway, the rise being less than one-tenth of

the span. The whole of the arching has been effectually protected from the effects of damp by a thick coating of asphaltum. The line then passes over the Regent's Canal by an iron bridge, the general appearance of which has been much admired; two main ribs of iron of fifty-four feet span, partly on the bow suspension principle, are thrown over the canal, to which transverse girders are fixed, supporting the roadway, on which are laid longitudinal sleepers of timber receiving the rails, an ornamental railing gives a finish to the whole. Passing successively over the river Lea, Grove Road, Coborn Road, Fairfield place, and Old Ford Lane Bridges, besides numerous other smaller archways, the railway passes over the Stratford marshes within a few feet of one of the extensive reservoirs of the East London Waterworks, crossing the river Lea by an arch of 70 feet span, rising one-fourth only; the arch is turned in 10 half brick rings; the appearance of this bridge (as we expressed in our review of Cresy's work on bridges in which drawings of it appear), is at once light and elegant, although sufficiently massive to prevent any idea of weakness. The embankment beyond the river Lea is 25 feet in height, in the formation of which considerable difficulty occurred owing to the very unstable nature of the ground on which it was raised, it being, in fact, a mass of spongy vegetable matter to a very considerable depth. Much assistance was derived in the execution of this part of the work by the formation of a staging on rough piles in advance of the embankment, and on which the wagons were run and tipped with great rapidity; of course by this means the earth was deposited over the subsoil to any required height, and the tendency of the ground "to spew up" prevented. On this part of the line there are numerous bridges over the various streams and rivers which the railway intersects, some of which are of considerable magnitude, such as the Stratford viaduct of five arches, each thirty-six feet span, Kent's Mill Bridge, of four arches, and the Abbey River Bridge, all of which are over tidal currents, besides numerous other small archways. The Stratford station is erected after the style of a plain Italian villa, fitted up with waiting-rooms, carriage shedding, engine-house, and repairing workshops for the engines. The depth of the cutting which immediately follows this station varies from ten to twenty feet. The Ilford station, which is only now being erected, is obviously incomplete. The tunnel or bridge at the crossing of the great Essex road evinces great judgment, it is 130 feet long, with iron girders resting on the abutment walls, from flanges on their lower parts small arches in cement are turned, carrying the turnpike road above; a little beyond this are some well executed culverts formed with iron pipes 3 feet diameter. The portion of the railway now open to the public, terminates at Barrack Lane, immediately adjacent to the town of Romford; the total distance is about ten miles and a-half, which the trains will accomplish in less than half an hour. The whole of the gradients are favorable. It may not be generally known that this line is laid down to a 5 feet gauge, which without greatly increasing the weight of the engines, gives them great mechanical advantages which they have not failed to turn to account.

The engineer to the line is Mr. Braithwaite, to whom much praise is due for the generally efficient manner in which the works and engineering difficulties (not a few) have been executed.

*The Dundee and Abroath Railway.*—This railway is about fourteen miles in length, with a capital of 100,000*l.* The greater part of the line is carried along the sea shore, through property presented by Lord Panmure to the company. This railway is remarkable for the limited works required

in its construction, and they of scarcely any magnitude except at the end next Dundee, where there is a cutting about a half a mile in length through different strata, composed of gravel, sand, and rock.

*London and Croydon Railway*—On Saturday, the 1st ultimo, this line was opened by the directors, together with deputations from the London and Brighton and the Greenwich Railway Companies. At a little after one o'clock the trains, two in number, started. The journey down was accomplished in twenty minutes. The station at New Cross is fitted up with every convenience for passengers, &c.; at the back there is a most spacious engine house, of an octagonal shape, and is calculated to hold, exclusive of tenders, sixteen engines.

*Brandling Junction Railway.*—An experimental trip was performed on the Brandling Junction Railway, on Thursday, May 30, with three beautiful locomotive engines and wagons attached, which ran with a number of passengers from the Monk Wearmouth station to Boldon, where they took in water and then returned. The experiment was in all respects most satisfactory; the railway stood the test to admiration, and the engines performed their work as steadily and smoothly as if they had been used to it. The grand opening of this promising and useful undertaking will take place on the 18th, being the anniversary of the glorious battle of Waterloo. —*Newcastle Journal.*

*Birmingham and Derby Junction Railway.*—On Wednesday, the 29th May, the directors of the above railway inspected the line between Derby and the junction with the London and Birmingham Railway at Hampton-in-Arden, a distance of about thirty-eight miles. They proceeded from the bridge over the river Dove, a distance of seventeen miles, towards Tamworth, with a train of passenger carriages, drawn by an engine built by Messrs. Charles Tayleure and Co., of Warrington. The line is generally, and on many portions, remarkably straight. The gradients are so extremely favorable that it may almost be said to be a level, and the motion, we are assured by a gentleman who accompanied the directors, was easy and smooth to a degree which they had seldom experienced on any other railway. By the simplicity of construction and stability of the bridge over the Tame and Trent, at their junction near Alrewas, over which the train passed at speed, the directors were strongly impressed. It is near this point that the intended junction with the branch of the Manchester and Birmingham Extension Line is to be effected, by which the traffic from Lancashire to Derby, Nottingham, and the eastern parts of the kingdom, will eventually be brought along the line of this railway. Though some portions of the line were not in so complete a state as to render the further passage of the train advisable, the greater portion of the permanent way was laid, and in a few weeks the engines will be able to pass along the whole distance.—*Midland Counties Herald.*

*Grand Junction Railway.*—The rates for the carriage of merchandise on this railway were reduced on the 1st inst. The principal reductions are on goods which were formerly charged 1*s.* 6*d.* and 1*s.* 3*d.* per cwt.; the former charge having been reduced to 1*s.* 3*d.* and the latter to 1*s.* 1½*d.* per cwt. The company are now carrying throughout between Liverpool, Manchester and London.

*Manchester and Leeds Railway.*—An experimental trip on this line of railway was made on Friday, 31st May, by the directors and a party of their friends, consisting altogether of about sixty gentlemen, who proceeded in a train from the station in Manchester to the entrance of the summit tunnel, about three quarters of a mile beyond Littleborough, a distance of

sixteen miles from Manchester. The directors promised, in one of their earlier reports, that this portion of the line would be completed in May, 1839; and, notwithstanding many unexpected difficulties in the progress of the works, they were enabled in some measure to redeem their pledge by the above trip, made on the last day of the month, although the extent of the line travelled over will not be ready for the conveyance of passengers before the beginning of July. The rails on the line are about 60lbs. to the yard. They are laid to such a width, that, in the event of the extension lines uniting, the Leeds and Liverpool and Manchester Railways, at the Hunt's Bank Station, the same engines, carriages, or wagons may proceed forward; there will be a space of six feet between the double line of rails. There are to be three classes of carriages, which will be distinguished by numbers instead of names.—*Abridged from the Manchester Guardian.*

*The York and North Midland Railway.*—On Wednesday, the 29th ultimo, a portion of this important national and commercial undertaking was opened, from the terminus at York to the junction with the Leeds and Selby Railway, near South Milford, which forms an uninterrupted railway communication between York and Leeds, and York and Selby, and the several intermediate places. The whole line is intended to be completed by the time the North Midland, the Leeds and Manchester, and the Great North of England Railways (of which ti will form the connecting link) can be opened.—*York Courant.*

*Opening of the Aylesbury Railway.*—On Monday, June 10, the town of Aylesbury was a scene of bustle and vivacity scarcely to be credited. Before six o'clock in the morning, musicians accompanied by persons bearing flags on which suitable devices were inscribed, paraded the streets, after which they proceeded in procession with the directors and their friends to the station. A little after seven o'clock a train started for the terminus, at the junction between Aylesbury and the London and Birmingham line.

*London and Southampton Railway.*—A distance of twenty miles additional of this railway was on Monday, the 12th ultimo, opened to the public, viz., twelve miles from Southampton to Winchester at the one end, and eight miles from the Winchfield and Hartley-row station to Basingstoke at the other.—*Times.*

*Versailles Railway.*—The first trial of the whole extent of railway by St. Cloud to Versailles was made on Thursday week. A locomotive engine ran the whole distance from the station in Paris to the Rue St. Symphorien, at Versailles. At all the points near Ville-d'Avray, Sevres, Chaville, Viroflay, and Montreuil, the inhabitants came out in crowds to witness the spectacle. This railway branches from the St. Germain railway, and was undertaken in 1838, by the Paris Rothschilds. It has been two years and a half in progress, and passes through a difficult country. It was opened on Sunday, the 4th instant, and carried 12 or 15 thousand persons, giving a return of 2000*l.*

*Railway from Venice to Milan.*—One of the most stupendous works of modern times is a projected railroad from Venice to Milan, connecting the seven richest and most populous cities of Italy with each other, Venice, Padua, Vicenza, Verona, Mantua, Brescia, and Milan; the most gigantic portion will be the bridge over the Lagoons, connecting Venice with the main land. The length of the railroad will be 166 Italian (about the same in English,) miles, passing through a population of three and a half millions, the seven cities having alone a population of half a million, viz.,

Venice, 120,000, Padua, 44,000, Vicanza, 50,000, Verona, 46,000, Mantua, 34,000, Briscia, 42,000, and Milan, 180,000 inhabitants, to which may be added 20,000 foreigners in Venice and Milan.—*Foreign Quarterly Review.*

*Russia.*—At a general meeting of the shareholders in Zarskojeselo railroad, held at St. Petersburgh at the end of last month, it appeared by the report of the directors, that the cost of the formation of the road and its *materiel* had amounted to 5,281,667 roubles. The original calculations were founded upon the anticipation of 300,000 passengers within the year, but, during the preceding twelve months, the number of travellers between the capital and Zarskojeselo had amounted to 500,000, and the number which passed along the whole line to and from Paulowsk was 707,091. The receipts amounted to 920,237 roubles. At the end of the first nine months the receipts exceeded the expenditure by 316,976 roubles. Of this balance 90,000 roubles were applied in paying the interest and reimbursing the loan from the crown; and 140,000 roubles to the payment of interest on shares; 15,848 roubles were divided, according to the statutes, among the directors; 1,555 roubles were paid to the chief engineer; and 69,572 roubles were carried to the reserved fund.

*Motto for a Locomotive Engine.*—Mr. Editor: Allow me to subscribe *a motto for a Locomotive*, the effusion of an ingenious friend, if you have a corner of your Journal to fill up, perhaps for the novelty and "naivete" of the idea you will inserst it in your next:—

"Upon the four elements I feed,
Which life and power supply,
To run my race of boundless speed,
By loss of one I die."

J. H.

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RAILWAY, CANAL, AND ROAD TRAVELLING IN FRANCE.

The current estimates of the French board of works, which amounted to 40,000,000f., (1,600,000*l.*) in 1831, were raised to 45,000,000f. (1,800,000*l.*) in 1837. This very considerable sum is devoted to the maintenance of the roads, bridges and canals. An engineering overseer, who is attached to the administration of each department, directs and manages the works to which the money is applied. Besides these current estimates, a law passed in 1833, gave rise to a vote of extraordinary supplies for public works, which provides for the more important repairs, the completion of undertakings still unfinished, and the construction of new lines of communication. This additional vote, which has been increased by similar laws, passed in the years 1835, 1836, 1837, and 1838, has now reached as large a sum as 350,000,000f., (14,000,000*l.* sterling.) Out of this fund the Chambers have granted 27,000,000f. for the improvement of harbors; 64,000.000f. for the amelioration of the river navigation; 63,000,000f. for the completion of canals began in 1832; to which has been added a vote of 85,000,000f. for a lateral canal to Garonne, between Toulouse and Bordeaux, and a junction canal between the Maine and the Rhine; lastly, the high roads have obtained a grant of 107,000,000f. The *conseils-generaux* in the various departments have voted for the extension of the departmental roads not less than 60,000,000f. When the works now undertaken, and in progress, are finished, there will be in France nearly 8,000 leagues of high roads of the first class (*routes royales,*) 8,500 leagues of high roads of the second class, (*routes departmentales,*) and 850 leagues of canals. An unbroken line of internal navigation will be opened from Havre to Marseiles, and from Stratsburgh to Havre. The principal deficiency in the means of communication in France is celerity. The steamboats have great-

difficulty in ascending against the stream of the larger rivers. The only canal on which the system of fly-boats has been borrowed from the Scotch and English canals, or at least, borrowed with success, is the Canal du Midi, from Toulouse to Cette. The mails, indeed, are transported at an average speed of three leagues an hour. The use of the telegraph is confined to the business of the Government. The railroads which have been executed, up to the present time, are inconsiderable, and the railroads at this moment in execution are for very short distances, their whole united length not exceeding forty-four leagues.—*Civil Engineer and Architect's Journal.*

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*The Cyclops Steam Frigate.*—This magnificent vessel, the largest steam man-of-war in the world, was lately launched from Pembroke Dockyard. Her dimensions are as follows:—Length, 225 feet, beam between paddles 38 feet, depth of hold 21 feet. Her tonage is about 1,300, being 200 tons larger than the Gorgon, launched from the same slip about eighteen months since. Her equipment, as a man-of-war, will be the same in all respects as a frigate, having a complete gun or main deck as well as an upper or quarter deck. On the main deck she will carry eighteen long 36-pounders, and on the upper deck four 48-pounders and two 96-pounders on swivels, carrying a ball of ten inches diameter, and sweeping round the horizon 240 degrees. The Cyclops, like the vessel already referred to, will be commanded by a post captain, these two being the only steamers taking a frigate's rank. Her crew will consist of 210 men, 20 engineers and stokers, and a lieutenant's party of marines, who will have charge of the guns, all of which move upon slides and fixed pivots, thereby taking a much wider range than the ordinary carriage can give. She will be schooner rigged, but her foremast will be of the same scantling and height as that of a 36-gun frigate. Her draught of water, with all on board, including six months' provisions, completely armed, and with twenty days fuel, will be fifteen feet. This quantity of fuel (400 tons) will be carried in the engine room, but there is space in the fore and aft holds for ten days' more coal, making in all sufficient fuel for a thirty days' run. She has an orlop deck below the gun deck, of dimensions so magnificent that there is room to stow with comfort eight hundred troops and their officers, so that, taking her all in all, the Cyclops may be considered the most powerful vessel in her Majesty's service.

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*New Light for Lighthouses.*—A letter of the 10th March from Trieste, states that a new system of producing light for lighthouses has been invented by a serjeant-major in the Austrian artillery, named Selckonsky.—The apparatus consists of a parabolic mirror, 62 inches by 30, with a twelve inch focus, and the light is produced by a new kind of wax candle, invented by M. Selckonsky. It has been tried under the inspection of the Austrian Lloyd's Company in the port of Trieste, by being erected on the mast of a vessel. The light is said to have illuminated the whole of the port and the surrounding parts of the town equal to the moon at full, and at the distance of six hundred yards the finest writing could be read. A second trial has been made in bad weather, and the result was proportionably favorable.—*Civil Engineer and Architect's Journal.*

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## FAILURE OF THE HYTHE BRIDGE AT COLCHESTER—MR. BRAITHWAITE'S REPORT THEREON TO THE CORPORATION.

This bridge was erected from the plans of a local architect, over the river

Colne, at a place called the Hythe, adjoining the town of Colchester, and up to which point the river is navigable for sailing vessels. The structure was completed, and the road formed and opened for traffic by the latter end of March in the present year; although up to that time the centres had not been eased.

On the 1st of April, on their attempting to remove the centres, the arch followed it; and in their cutting away a bracing piece, the whole structure suddenly fell in—the centres being then unable to sustain the weight thrown upon them. The dimensions of the bridge were as follows: Span of the arch (which was segmental) 58 feet—the rise or versed sine being ten feet; thickness of arch throughout 1 foot six inches; and from face to face of ditto 23 feet. The longitudinal depth or thickness of the abutments, 10 feet; vertical thickness of the abutments, 5 feet—resting on planking laid transversly in sills, which were bedded in a foot and a half of concrete below which, was a loosish strata of gravel. The arch was turned in four half brick rings in cement, with about ten pieces of hoop iron, bedded longitudinally between each ring, and four iron tye-rods with washers placed transversely through the arch; the spandrells were filled up with loose earth, and two small counterfeits, which were carried up in spandrell walls (with the addition of the face walst) had to resist the whole thrust of the arch. Mr. Braithwaite, the engineer in chief of the Eastern Counties railway, was applied to by the corporation to report on the cause of the failure; and after minutely examining the plans and remains of the structure, he gave it as his decided opinion, that the former were so radically bad that it was impossible for the structure to have stood; and on the other hand, that the workmanship was so defective, that with the best and most carefully prepared plans, it must have fallen. Mr. Braithwaite's estimate for a new bridge is 2,200*l.*—the cost of that just destroyed, was about 1,300*l.*

The reverse quoins of the abutments have subsided about an inch and a half; the cement in the arch, it is apparent, was quite killed by the too great admixture of sand; at the keying-in of the arch, such a monstrous want of care was exhibited, as to be worthy of notice—it appears they did not guage their courses, or if so, did not work to it; as, when they arrived at the course of key bricks, there was a space of about 4½ or 5 inches left; now instead of taking out about half a dozen or more courses of bricks—picking out the largest, laying them dry, and then grouting them in—they keyed-in with three-quarter ragged batts, laid longitudinally!—*Civil Engineer and Architect's Journal.*

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## THEORY OF THE STEAM-ENGINE.

### CHAPTER I.—PROOFS OF THE INACCURACY OF THE ORDINARY MODE OF CALCULATION.

(Continued from page 255.)

*Section V.—New proofs of the accuracy of the theory proposed, and of the inaccuracy of the ordinary theory.*

As we shall draw from the examination of locomotive engines, the greater part of the considerations we are now about to offer on the two theories, we will first observe, with respect to those engines, that we look upon them as being incontestably more proper than all others to make known the true theory of the motion and action of steam. The reasons of this preference are, 1st, that those engines are of a remarkable simplicity; 2d, that the determination of the resistance which they have to move is easy, and susceptible of great exactitude, since it consists merely in weighing the train they have to draw; whereas to estimate the resistance opposed to stationary engines

often requires calculations both various and uncertain; 3d, that the friction of locomotive engines is known from our own experiments, and with a degree of precision that seems to be trustworthy, since that friction has been determined by several methods which have served to verify each other; 4th, that it is easy to observe a locomotive engine under a hundred circumstances different from each other, by varying at pleasure the load and the velocity, which may be done in very wide limits; whereas in stationary engines, it happens most frequently that the resistance to be moved is incapable of variation, whence results that the steam is never seen to act but in one manner, and thus the study of those engines reduces itself nearly to that of one particular case.

To return to the theory we have exposed, it visibly rests chiefly on this, that though the steam be formed in the boiler at a certain pressure P, yet in passing into the cylinder it assumes a pressure R, strictly determined by the resistance against the piston, whatever else may be the pressure in the boiler; so that, according to the intensity of that resistance, the pressure in the cylinder, far from being always equal to that of the boiler, or from differing always from it in any constant ratio, as is believed, may at times be fully equal to it, and at other times considerably different. Thus, when in the ordinary theory, the calculation is performed under the supposition that the steam acts in the cylinder at the pressure of the boiler, an error often very considerable, and independent of all the real losses to which the engine is liable, is introduced into the calculation; since a force is considered as applied, which is two or three times greater than the real one. No wonder then it became necessary to use a coefficient $\frac{1}{3}$ or $\frac{1}{4}$, which makes the supposed losses of the engine appear enormous, whereas the real error is in the very basis of the calculation itself.

We have already proved this mode of action of the steam in the cylinder, from the consideration of uniform motion; but in examining what takes place in the engine, we shall presently find many other proofs.

1st. The steam being generated at a certain degree of pressure in the boiler, passes into the steam-pipe, and from thence into the cylinder; there it dilates at first, because the area of the cylinder is ten or twenty times that of the pipe, and it would quickly rise to the same degree of pressure as in the boiler, were the piston immoveable. But as the piston, on the contrary, opposes only a certain resistance determined by the load imposed on the engine, 40 lbs. for instance, per square inch, it will give way as soon as the elastic force of the steam in the cylinder shall have attained that point. A piston sustaining a resistance of 40 lbs. per square inch is nothing more than a valve loaded with 40 lbs. per square inch. Were the communication perfectly free between the boiler and the cylinder, without tube or contraction, so that the two vessels should form but one, the piston would become a real valve to the boiler; and that valve yielding before the safety valve, which is loaded perhaps at 50 lbs. per square inch, the steam could never rise in the boiler above the pressure of 40 lbs. per square inch. Since the communication between those two vessels is not wholly free, the piston is not a valve to the boiler, but it still continues to be one to the cylinder. Wherefore the pressure in the cylinder can never exceed the resistance of the piston.

2dly. Another consideration will readily prove to us again that the pressure of the steam in the cylinder must necessarily be regulated, not by the pressure in the boiler, but by that of the resistance. In fact, were it actually true that the steam be expended in the cylinder, either at the pressure of the boiler, or at any other pressure that were in any fixed ratio whatever

to that of the boiler, then, since the quantity of steam raised per minute in the boiler would be expended by the cylinder at one and the same pressure in all cases, and would consequently fill the cylinder a fixed number of times in a minute, it would follow that the engine, so long as it should work with the same pressure in the boiler and the same apertures or steam passages, would assume the same velocity with all loads. Now, we see that the very contrary takes place; for the lighter the load, the greater becomes the velocity of the engine.

The effect produced is explained easily, in considering what really passes in the engine. If it be supposed that the evaporation, producing, for instance, 200 cubic feet of steam per minute at the pressure of the boiler, be sufficient to fill the cylinder 200 times, when the piston is loaded with the resistance R; as soon as that resistance R shall be replaced by a resistance $\frac{1}{2}$ R, the same mass of steam assuming in the cylinder a pressure of only half of what it was before, will furnish 400 cylinders-full of steam per minute at the new pressure. It is then clear that the resistance $\frac{1}{2}$ R will be set in motion with a velocity double that of the resistance R; which does in fact accord with observation, if, in estimating that resistance, account be taken of all the partial resistances and frictions really opposed to the motion of the engine.

3dly. Applying the same reasoning inversely, we see that, were the pressure of the cylinder in a fixed ratio with that of the boiler, or were it constant so long as that of the boiler remained the same, then in calculating the effort of which the engine is capable, this would always be found the same, whatever might be the velocity of the piston. Thus, at any velocity whatever the engine would always be capable of drawing the same load. Now this result again is contrary to experience; and the reason of it is that the greater the velocity of the piston, the lower the pressure in the cylinder; whence results, that the load the engine is capable of moving diminishes in the same proportion.

4thly. Another proof no less evident is easily adduced. Were it true that the steam be expended by the cylinder at a pressure equal to that of the boiler, or in any fixed ratio to it, indicated by any coefficient whatever, since any one locomotive engine requires the same number of turns of the wheel, or the same number of strokes of the piston to traverse the same distance, it would follow that so long as these engines work at the same pressure, they ought in all cases to consume the same quantity of water for the same distance. Now, the quantity of water evaporated, far from being constant, decreases, on the contrary, with the load, as may be seen in the experiments we have published on this subject. The *Atlas* engine, for instance, evaporated 132 cubic feet of water in drawing 195·5 tons, and 95 cubic feet only in drawing 127·6 tons. Since the same number of cylinders-full of steam was expended in each case, the steam of the first must have been of a density different from that of the second; and here again it is manifest that, notwithstanding the equality of the pressure in the boiler, and of the opening of the regulator in the two cases, the density of the expended steam followed the intensity of the resistance, that is to say, the pressure of steam in the cylinder was regulated by the resistance.

5thly. From the same cause, since the consumption of fuel must be in proportion to the evaporation effected, it would follow too, were the ordinary theory exact, that the quantity of fuel consumed by a given engine would always be the same for the same distance, whatever might be the load. Now, we find again, by experiment, that the quantity of fuel, on the contrary, diminshes with the load, conformably to the explanation we have given of the effects of the steam in steam-engines.

6thly. It is clear, moreover, that if the pressure in the cylinder were, as it is thought, constant for a given pressure in the boiler, then after an engine has been found capable of drawing a certain load with a certain pressure, and of communicating to it a uniform motion, it would follow that the same engine could never draw a less load with the same pressure in the boiler, without communicating to it a velocity indefinitely accelerated; since the power having been found equal to the resistance in the first case, would necessarily be superior to the resistance in the second. Now, experience proves that in the second case the motion is quicker, but no less uniform than in the first; and the reason is, that though the steam be generated in the boiler at a pressure more or less elevated, which matters little, yet in passing into the cylinder it always assumes the pressure of the resistance; whence results that the power is no more superior to the resistance in the second case than in the first, and that the motion ought therefore to remain uniform.

7thly and lastly. On looking over our experiments on locomotives, the same engine will be seen sometimes drawing a very light load with a high pressure in the boilder, and sometimes, on the contrary, a very heavy load with a low pressure. It is then impossible to admit, as the ordinary theory would have us, that there is any fixed ratio whatever between the two pressures. This effect, moreover, is most easy to explain; for it depends simply on this, that in both cases the pressure in the boiler was superior to the resistance against the piston, and no more was needful in order that the steam, generated at that pressure, or at any other fulfilling merely that condition, might on passing into the cylinder, assume the pressure of the resistance.

It is moreover to be observed, that these effects cannot take place in a locomotive steam-engine, without equally occurring in a stationary one; for the steam acts in the same manner in the cylinders of both, and it is unimportant whether during the action of that steam, the engine moves or remains at rest, or whether its own weight do or do not form a part of the load imposed on the piston.

All these proofs then establish clearly that the pressure of the steam in the cylinder, is strictly regulated by the resistance on the piston and by nothing else; and that all methods, like that of the coefficients, founded on the principle of its being in any fixed ratio whatever with the pressure in the boiler, are necessarily inaccurate.

It is, however, essential to observe, that we wish to establish by these reasonings, that, since the pressure in the cylinder is fixed *a priori*, it cannot depend on the pressure of the boiler; but we believe, on the contrary, as will be seen, Sect. VII., that the pressure in the cylinder being once regulated by the resistance on the piston, that of the boiler afterwards depends on it, in proportion to the size of the passages, the volume of steam produced, and the weight of the safety-valves. It would only be for want of making this needful distinction, that we could be thought to admit an entire independence between the two pressures.

### *Section VI.—Comparison of the two theories in their application to particular examples.*

The foregoing already establishes sufficiently, in principle, the accuracy of the theory which we propose, and the inaccuracy of that which has hitherto been made use of. It may, however, be thought by some that the inaccuracy alleged against the latter is of trifling importance, and that in practical examples it gives results very near the truth at least, if not quite correct. We are

now, therefore, about to submit that method as well as our own to the scrutiny of practice. When in action together, the difference of the results to which they lead will be apparent, and it will be recognized which of the two is more in harmony with the facts; and finally, a clear idea will be formed of the causes from whence the errors of the ordinary theory derive.

The coefficient of correction for high pressure steam-engines without expansion and without condensation, not being fixed to the same amount by the authors who have treated on these subjects, suppose it be attempted to determine it from the two following facts of which we were eye-witnesses.

1. The locomotive engine *Leeds*, which has two cylinders of 11 inches diameter; stroke of the piston, 16 inches; wheels, 5 feet; weight, 7·07 tons; drew a load of 88·34 tons, ascending a plane inclined $\frac{1}{1300}$, at the velocity of 20·34 miles per hour; the effective pressure in the boiler being 54 lbs. per square inch, or the total pressure 68·71 lbs. per square inch.

2. The same day the same engine drew a load of 38·52 tons, descending a plane inclined $\frac{1}{1094}$, at the velocity of 29·09 miles per hour; the pressure in the boiler being precisely the same as in the preceding experiment, and the regulator opened to the same degree. These experiments are given, pages 233, 234, of our *Treaties on Locomotives* (1st edition).

Reckoning, on the one part, the *theoretical* effort applied on the piston according to the ordinary calculation; and on the other part, the effect really produced, viz., the resistance of the load together with that of the air against the train, we find, refering the area of the pistons and the pressure to the square foot:

| | | lbs. |
|---|---|---|
| 1st Case. | Theoretical effort applied to the piston, according to the ordinary calculation, 1·32×(68·71 ×144) | 13060 |
| | Real effect | 8846 |
| | Coefficient of correction | ·68 |
| 2d Case. | Theoretical effort, the same as above | 13060 |
| | Real effect | 6473 |
| | Coefficient of correction* | ·50 |

The mean coefficient between the two is ·59. We thus find three differ-

* The detailed calculation of the effects produced is this:

| | | | lbs. |
|---|---|---|---|
| 1st Case. | Resistance of the 88·34 tons, at 7 lbs. per ton (*v.* 2d edition of *Treatise on Locomotives*) | | 618 |
| | Gravity of 95·41 tons (train and engine) on a plane rising $\frac{1}{1300}$ | | 164 |
| | Resistance of the air against the train, at the velocity of the motion | | 134 |
| | Resistance overcome at the velocity of the wheel | | 916 |
| | And as that resistance is here measured at the velocity of the wheel, it produced against the piston, a force augmented in the inverse ratio of the velocities of the piston and of the wheel, that is to say a resistance of 916 × 5·9 | | 5404 |
| | Add for the pressure of the atmosphere against the piston, the engine being a high pressure one, 1·32 × (14·71 × 144) | | 2796 |
| | And for the pressure caused by the blast-pipe 1·32 × (3·4 × 144) | | 646 |
| | Total resistance against the piston, exclusive of friction | | 8846 |
| 2d Case. | Resistance of the 38·52 tons | 270 | |
| | Gravity on the plane descending $\frac{1}{1094}$ — | 93 | |
| | | 177 | |
| | Resistance of the air | 282 | |
| | Resistance against the wheel | 459 | |
| | Or against the piston; 459 × 5·9 | | 2708 |
| | Add for the pressure of the atmosphere | | 2796 |
| | And for the pressure caused by the blast-pipe 1·32 × (5·1 × 144) | | 969 |
| | Total resistance against the piston, exclusive of friction | | 6473 |

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ent coefficients. Let the first be chosen, an error will be made in the second case; let the second be preferred, and an error will be made in the first case. Let the third be admitted, and the error will only be divided between the two cases. In any way error is inevitable, and that, of itself, suffices to prove that any method, like the ordinary theory, which consists in employing a constant coefficient, is necessarily erroneous, whatever be the coefficient adopted, and to whatever system of engine the application be made; for it is evident that the same fact would occur in every species of steam-engine. It might only be less striking, if the velocities in the two instances were less different, and that is what has hitherto prevented the error of that method from being perceived; for all the engines of the same system being imitated from each other, and working nearly at the same velocity, from a factitious limit that had been imposed on the velocity of the piston, the same coefficient of correction appeared tolerably to suit them all.

In stationary engines, moreover, it was impossible, for want of precise determinations of the frictions, to separate that part of the result which is really attributable to them, from that part which constitutes a veritable error. But here we easily obtain the conviction that neither of these coefficients of correction represent, as we are told, the frictions, losses, and divers resistances of the engine; for direct experiments on the engine under consideration, which are given in our *Treatise on Locomotives*, enable us to estimate separately all those frictions and resistances. Now from these experiments, the friction of that engine, when isolated is equivalent to a force of 82 lbs. applied to the wheel, and that friction afterwards augments by 1 lb. for every ton of load added to the engine.

Besides, the losses to which the engine is liable either from condensation or from waste of steam (during its passage from the boiler to the cylinder) are nothing, or at least inconsiderable.

It becomes easy, then, with these elements, to estimate the amount of the frictions really experienced by the engine. Now in calculating them separately thus, we find:

1st Case. Friction 1257 lbs., or ·10 of the theoretical result.

2d Case. Friction 873 lbs., or ·07 of the theoretical result.*

Thus it appears that in these two cases the friction omitted in the calculation amounted really to but 10 and 7 hundredths of the theorectic results; and if $\frac{1}{20}$ or ·05 of loss be added for the filling up of the vacant spaces in the cylinder, which we have not been able to estimate in lbs., they will amount to ·15 and ·12; whereas the coefficients of correction raise them to ·32 on the one part, and to ·50 on the other; that is, from two to four times what they really are. Deducting, then, from these coefficients, the true value of the frictions and losses, it will be found that the theoretical error which this method brings into the calculation, under the denomination of friction, is 17 per cent. of the *total force of the engine* in one case, and 38 per cent. in the other.

It will now be observed that, from the preceding determinations, viz., of

* We have in fact:

| | | lbs. | |
|---|---|---|---|
| 1st Case. | Friction of the engine without load . . . . . | 82 | |
| | Additional friction for a resistance equivalent to $\frac{916}{7}$ = 131 tons . . . . . . . . . . | 131 | |
| | | 213 | |
| | Which produces against the piston 213 × 5·9 . . . . . . | | 1257 |
| 2d Case. | Friction of the engine without load . . . . . | 82 | |
| | Additional friction for a resistance equivalent to $\frac{459}{7}$ = 66 tons . . . . . . . . . . | 66 | |
| | | 148 | |
| | Which produces against the piston 148 × 5·9 . . . . . . | | 873 |

the resistances first and then of the frictions, we have for each of the two cases which occupy our attention, the sum of the total effects really produced by the engine, that is:

| | | lbs. |
|---|---|---|
| 1st Case. | Resistances . . . . . . . . . . . | 8846 |
| | Frictions . . . . . . . . . . . . | 1257 |
| | | 10103 |
| 2d Case. | Resistances . . . . . . . . . . . | 6473 |
| | Frictions . . . . . . . . . . . . | 873 |
| | | 7346 |

We are now, therefore, enabled to compare these effects produced, with the results, either of the ordinary calculation, or of that which we propose to substitute for it.

1st. In applying, first, the ordinary calculation with the mean coefficient ·59 determined above, and comparing its result with the real effect, we find:

| | | lbs. |
|---|---|---|
| 1st Case. | Effort applied on the piston, from the ordinary calculation, $1{\cdot}32\times(68{\cdot}71\times 144)\times{\cdot}59$ . . . . . | 7705 |
| | Effect produced, including all frictions and resistances | 10103 |
| | Error, over and above the frictions and resistances | 2398 |
| 2d Case. | Effort applied on the piston, from the ordinary theory, the same as above . . . . . . . . . | 7705 |
| | Effect produced, including, &c. . . . . . | 7346 |
| | Error, besides frictions and resistances . . . . | 359 |
| | Mean error of the two cases . . . . . . . | 1378 |

It is plain, then, that there would be risk of a very great error in attempting to calculate the effects of this engine with the coefficient ·59; but it is plain, moreover, that in applying any other coefficient *whatever*, the error would only be transferred from the one case to the other, without ever disappearing; and thus, in fact, the coefficient ·59 has almost rendered null the error of the second case above, by transferring it to the first.

To apply now our formula relative to the same problem, viz.,

$$aR = \frac{mSP}{v},$$

nothing more is requisite than to replace the letters $m$, S, P, and $v$ by their respective values, taking care only to refer all the measures to the same unit.

Thus, P is the total pressure of the steam in the boiler, viz., 68·71 lbs. per square inch, or $68{\cdot}71\times 144$ lbs. per square foot.

$m$ is the ratio of the volume of the steam, at the total pressure of 68·71 lbs. per square inch, to the volume of the same weight of water; and, according to tables which will be given in the following chapter, $m=411$.

S is the volume of water evaporated per minute, and converted to use in the cylinders. Now, during the journey, of which the first of these experiments was a part, the engine evaporated 60·52 cubic feet of water per hour, (*Treatise on Locomotives*, 1st edition, page 175); which, after a deduction of $\frac{1}{5}$ for the loss of steam by the safety valve, measured, as explained in section VII., and of $\frac{1}{20}$ on the rest for the filling up of the vacant spaces in the cylinder, leaves an *effective* evaporation of ·77 cubic feet of water per minute. We here then have $S={\cdot}77$.

Finally, $v$ is the velocity of the piston; and as the engine moved at a ve-

locity of 20·34 miles per hour in the first case, and of 29·09 miles per hour in the second, which correspond respectively to 298 and 434 feet per minute for the piston, we shall have successively $v=298$ and $v=434$.

Hence the formula gives:

| | | lbs. |
|---|---|---|
| 1st Case. | Effort exerted by the engine at the given velocity, from our calculation, $\dfrac{411\times{\cdot}77\times(68{\cdot}71\times144)}{298}$ . . . | 10507 |
| | Effect produced, including the frictions and resistances, as above . . . . . . . . . . . | 10103 |
| | Difference . . . . . | 404 |
| 2d Case. | Effort exerted by the engine at the given velocity, $\dfrac{411\times{\cdot}77\times(68{\cdot}71\times144)}{434}$ . . . . . . . | 7215 |
| | Effect produced, including, &c. . . . . . . | 7346 |
| | Difference . . . . . | 131 |
| | Mean difference of the two cases . . . . . | 267 |

We attain then the effect really produced, within a difference of only 267 lbs., a difference which is less than can generally be expected in experiments of this kind, wherein all depends on the management of the fire; whereas the preceding theory gives a *mean* and inevitable error of 1378 lbs., which is $\frac{1}{7}$ of the real effect of the first case, and $\frac{1}{5}$ of the real effect of the second.

2d. To continue the same comparison of the two theories, suppose it were required to calculate what quantity of water the boiler should evaporate per minute to produce either the first or the second effect. The mode of calculation followed by the ordinary theory consists, as we have said, in supposing, first, that the volume described by the piston has been filled with steam at the same pressure as in the boiler, and then in applying to it a coefficient of reduction for the losses.

Now, in the first case, the volume described by the piston at the given velocity, is $av=1{\cdot}32\times298=393$ cubic feet. If this volume had been filled with steam at the pressure of the boiler, it would have required an evaporation of water of

$$\frac{393}{411}={\cdot}96 \text{ cubic foot of water.}$$

But the real evaporation was no more than ·77. Therefore the theoretic evaporation of the first case requires a coefficient of

$$\frac{{\cdot}77}{{\cdot}96}={\cdot}81$$

In the second case, the evaporation similarly computed, supposing the steam to have acted in the cylinder at the pressure of the boiler, is

$$\frac{1{\cdot}32\times434}{411}=1{\cdot}39 \text{ cubic foot of water.}$$

So, for this case the necessary coefficient is ·55. In this problem, therefore, as in the preceding, no constant coefficient *whatever* can be satisfactory.

If, however, the calculation be performed with the mean coefficient ·68, there results:

1st Case. Evaporation per minute calculated by the ordinary theory,

with the coefficient ·68, $\frac{1{\cdot}32 \times 298}{411} \times {\cdot}68$ . . . . ·65

Real evaporation . . . . . . . . . . ·77

Error . . . . . . . . ·12

2d Case. Evaporation per minute, calculated by the ordinary theory,

with the coefficient ·68 $\frac{1{\cdot}32 \times 434}{411} \times {\cdot}68$ . . . . . ·95

Real evaporation . . . . . . . . . . ·77

Error . . . . . . . . ·18

The mean error committed is then $\frac{1}{2}$ of the evaporation; and, for the very reason that it is a medium, it may, in extreme cases, become twice as much.

This is the error committed, when a coefficient is sought *expressly* for the evaporation. But when, instead of that, the coefficient ·59, determined in the preceding problem from the comparison of the theoretic and practical effects, is used as a divisor, as by many authors it is, far greater errors are induced; for we find:

1st Case. Evaporation per minute, calculated by the ordinary theory, with the coefficient ·59 as a divisor, $\frac{298 \times 1{\cdot}32}{411 \times {\cdot}59}$ . 1·62

Real evaporation . . . . . . . . . . ·77

Error . . . . . . . . ·85

2d Case. Evaporation per minute $\frac{434 \times 1{\cdot}32}{411 \times {\cdot}59}$ . . . . . 2·36

Real evaporation . . . . . . . . . . ·77

Error . . . . . . . . 1·59

In our method, on the contrary, the evaporation necessary to put in motion the resistance $a$ R at the velocity $v$, is given by the formula

$$S = \frac{a \mathrm{R} \times v}{m \mathrm{P}}.$$

Which gives:

1st Case. Evaporation given by our calculation, $\frac{10103 \times 298}{411 \times (68{\cdot}71 \times 144)}$ ·74

Real evaporation . . . . . . . . . . ·77

Difference . . . . . . . ·03

2d Case. Evaporation given by our calculation, $\frac{7346 \times 434}{411 \times (68{\cdot}71 \times 144)}$ ·78

Real evaporation . . . . . . . . . . ·77

Difference . . . . . . . ·01

3dly and finally, for the case wherein the velocity of the piston is sought, supposing the resistance given, no method like the ordinary one could do otherwise than lead to error, but on this head comparison is unnecessary, since the problem has never yet been solved.

We shall merely, therefore, show the verification of our theory. The formula relative to this problem is:

$$v = \frac{m\mathrm{SP}}{a\mathrm{R}}.$$

And we find:

1st Case. Velocity of the piston, in feet per minute, calculated by our theory, $\frac{411 \times \cdot 77 \times (68\cdot 71 \times 144)}{10103}$ . . . . 310

Real velocity . . . . . . . . . . . 298

Difference . . . . . . 12

2d. Case. Velocity by our calculation, $\frac{411 \times \cdot 77 \times (68\cdot 71 \times 144)}{7346}$ . 426

Real velocity . . . . . . . . . . . 434

Difference . . . . . . 8

It consequently appears that in each of the three problems in question, the theory we propose leads to the true result; whereas the ordinary theory, besides that it leaves the third problem without solution, may, in the two others, lead to very serious errors.

Before abandoning this comparison we will recall attention to an effect, in the calculation of the ordinary theory, of which we have already spoken, but which is here found demonstrated by the facts. It is, that that calculation gives the same force applied by the engine in both the cases considered, notwithstanding their difference of velocity; and such will always be the result, since the calculation consists merely in multiplying the area of the piston by the pressure in the boiler, and reducing the product in a constant proportion. Thus the ordinary theory maintains in principle, that the engine may always draw the same load at all imaginable velocities. Again we see that, in the same computation, viz., that of the load or of the force applied, the evaporation of the engine is not mentioned; which implies that the engine would always draw the same load at all velocities, and whatever might be the evaporation of the boiler; which is impossible.

Lastly, we shall remark that, in the calculation made by the ordinary theory, in order to find the evaporation of the engine, no mention whatever is made of the resistance the engine is supposed to draw; so that the evaporation necessary to draw a given resistance, is independent of that resistance; another result equally impossible.

To these omissions, then, which we regard as errors of principle, and to other causes already noted, are to be attributed the deviations observable in the results of the ordinary theory in the examples proposed.

### *Section VII.—Of the area of the steam-passages.*

There yet remains one point which needs examination, and that is the area of the steam-passages, or the size of the opening of the regulator.

The ordinary theory recognizes in this opening a very important effect on the engine, since it affirms that by increasing or diminishing it, any desired pressure may be produced in the cylinder. Yet no means are afforded us of taking account of this opening in the calculation; unless obliged, as we are already, to have a coefficient for the useful effects and for every species of engine, and another for the evaporation, modified also for every system of engines, and again a different coefficient for all velocities, we be required to have a new one also for every opening of the regulator. But these coefficients are not given, and notwithstanding that the action of the engine is considered to change with the opening of the regulator, yet the calculation is always the same, and made with the same coefficient, whatever that opening may be.

Now, when a stationary engine is at work, its regulator is in constant motion by the effect of the *governor,* and, as it were, unperceived by the engineer. The calculation then of the ordinary theory will be continually at fault; it will be inexact in all cases and at all moments wherein the regulator shall happen to have an opening different from that for which the coefficient employed shall have been determined.

In the theory which we propose, on the contrary, account is taken of the opening of the regulator, or at least of the effects it produces, though its direct measure does not appear ostensibly in the equations. To set this fact in a perfectly clear light, we will first of all establish what are the real effects of the regulator.

We will first prove that the degree of opening of the regulator can have no influence on the pressure in the cylinder, but that its reaction, on the contrary, is upon the pressure *in the boiler;* we will then show that, whatever be the contraction of the regulator, the formulæ will keep account of it, and will continue to give the true effects produced; and finally, we will examine, under each circumstance, what changes do take place in those effects, by reason of the contracting of the orifice of the regulator.

1. It is supposed, in the ordinary theory, that the pressure of steam in the boiler being given and fixed, the contracting more or less of the aperture of the regulator may be made to produce at pleasure a certain pressure in the cylinder. But we have proved that the pressure in the cylinder is, on the contrary, always strictly determined, *a priori,* by the resistance on the piston; the greater or less opening, then, of the regulator can effect no change in it. Besides, how could the contracting of the passage change the *pressure* of the steam which issues through it? It may, we agree, change the *quantity,* because the smallness of the opening will prevent more than a certain portion from passing in a given time, but it certainly never can change its *pressure.* It will, in fact, always happen, that as soon as the steam, on passing into the cylinder, shall attain there the pressure of the resistance, the piston will recede and not allow the steam to assume a greater pressure. And if it be supposed that by enlarging the passage, the steam be made to flow in 10 times, 20 times, 30 times quicker, the piston will recede 10 times, 20 times, 30 times quicker also, since its motion is the result of the arrival of the steam; but never will the pressure of the steam exceed the resistance of the piston, since the piston being a valve to the cylinder, that would be supposing a boiler in which the pressure of the steam were greater than that of the valve.

(To be continued.)

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*Paris.*—A preliminary inquiry has been commenced by order of the Municipal Council of Paris on proposals for establishing two railroads from the capital, one to St. Maur, and the other to Sceaux. The first is intended to commence at the Rue Traversiere St. Antoine, passing through Bercy, St. Maude, Charenton and Vincennes; and the second at the Place de l'Observatoire, running through Gentilly, Arcueil, Bagnieux and Bourg la Reine.—*Commerce.*

*Havre Railroad Company.*—At a late meeting it was decided, at the pressing instance af M. Aguaudo, that in case it became impossible to give entire execution to the undertaking, it should be carried into effect as far as Rouen, and that the road should terminate, not at St. Sevres, as originally intended, but on the hights of Beauvoisin, passing by Blainville, and the branch lines on Louviers and Elbeuf being suppressed. This decision was definitely adopted, and no consideration, it is said, will induce the company to modify it.—*Civil Engineer and Architects' Journal.*

For the American Railroad Journal, and Mechanics' Magazine.

METEOROLOGICAL RECORD FOR THE MONTHS OF MAY and JUNE, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W.*)

| 1839 | Thermometer. | | | | | |
|---|---|---|---|---|---|---|
| May | Morn. | Noon. | Night | Wind. | Weath. | Remarks. |
| 1 | 65 | 78 | 74 | SE | cloudy | shower in evening |
| 2 | 64 | 74 | 70 | S | .. | evening heavy thunder shower rain and hail |
| 3 | 65 | 71 | 68 | NE | clear | |
| 4 | 54 | 70 | 70 | calm | .. | |
| 5 | 67 | 77 | 72 | NE | .. | |
| 6 | 59 | 78 | 73 | .. | .. | |
| 7 | 70 | 80 | 75 | calm | .. | |
| 8 | 68 | 79 | 76 | SE | .. | |
| 9 | 70 | 84 | 78 | S | cloudy | morning flying clouds all day |
| 10 | 72 | 69 | 78 | .. | .. | 11½ o'clock A.M. a severe gale from sw, heavy |
| 11 | 66 | 79 | 79 | .. | .. | morning clear day { thunder and light show- |
| 12 | 71 | 76 | 72 | NW | clear | ers, evening clear and |
| 13 | 63 | 72 | 68 | .. | .. | showers in the night. |
| 14 | 54 | 80 | 68 | SW | .. | |
| 15 | 59 | 81 | 69 | SE | .. | |
| 16 | 69 | 78 | 66 | calm | cloudy | light shower morning heavy distant [thunders |
| 17 | 69 | 80 | 75 | .. | .. | evening, wind w [all day without rain, sw. |
| 18 | 68 | 78 | 74 | .. | .. | morning, clear day |
| 19 | 71 | 84 | 75 | SE | clear | at night heavy rain and thunder and lightning |
| 20 | 72 | 82 | 76 | calm | .. | cloudy morning clear day |
| 21 | 73 | 86 | 74 | .. | .. | " " " |
| 22 | 71 | 90 | 74 | SW | .. | |
| 23 | 68 | 90 | 76 | S | .. | |
| 24 | 72 | 87 | 82 | calm | .. | foggy morning |
| 25 | 72 | 84 | 79 | .. | .. | |
| 26 | 72 | 87 | 80 | .. | .. | |
| 27 | 70 | 89 | 80 | .. | .. | |
| 28 | 68 | 79 | 72 | NE | .. | |
| 29 | 68 | 80 | 76 | .. | .. | |
| 30 | 69 | 86 | 78 | SE | .. | |
| 31 | 68 | 89 | 80 | SW | .. | |
| | 67.3 | 81 | 71 | ............ | ............ | mean temp. of the month 73.1. |
| June | | | | | | |
| 1 | 70 | 88 | 79 | SW | clear | |
| 2 | 68 | 77 | 73 | .. | .. | |
| 3 | 74 | 76 | 70 | W | .. | showers in the morning and heavy thunder |
| 4 | 66 | 78 | 74 | NW | .. | " " [shower in the night |
| 5 | 67 | 78 | 75 | calm | .. | evening cloudy |
| 6 | 67 | 78 | 75 | NE | cloudy | rain light showers in the morning clear day |
| 7 | 70 | 89 | 82 | SE | clear | |
| 8 | 75 | 90 | 82 | .. | .. | |
| 9 | 77 | 89 | 86 | .. | .. | cloudy morning |
| 10 | 73 | 90 | 84 | .. | .. | foggy morning |
| 11 | 75 | 91 | 86 | .. | .. | " " |
| 12 | 75 | 90 | 80 | NE | cloudy | morning |
| 13 | 75 | 88 | 86 | .. | cloudy | evening |
| 14 | 78 | 83 | 84 | NW | .. | cloudy all day |
| 15 | 76 | 82 | 75 | SW | cloudy | evening, clear morning |
| 16 | 74 | 88 | 82 | .. | clear | |
| 17 | 88 | 88 | 83 | W | .. | |
| 18 | 75 | 88 | 74 | .. | .. | clear all day, heavy showers at night |
| 19 | 73 | 80 | 73 | S | cloudy | showers |
| 20 | 74 | 86 | 79 | .. | clear | |
| 21 | 80 | 90 | 86 | .. | .. | |
| 22 | 81 | 94 | 90 | calm | .. | |
| 23 | 80 | 94 | 90 | .. | .. | |
| 24 | 81 | 95 | 92 | .. | .. | the hottest day this year so far |
| 25 | 76 | 91 | 83 | SW | .. | heavy thunder shower at night |
| 26 | 70 | 88 | 86 | .. | .. | |
| 27 | 74 | 89 | 83 | .. | .. | |
| 28 | 80 | 95 | 90 | S | .. | showers at night, heavy thunder |
| 29 | 77 | 90 | 80 | .. | .. | |
| 30 | 79 | 85 | 80 | .. | .. | evening light shower and thunder |
| | 74 | 87 | 81 | ............ | ............ | mean temp. of the month 81.7 say 81. |

*St. Germain Railway.*—This railway has declared a dividend for the year, of seven and a half per cent.—*Galignani's Messenger.*

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 10. Vol. III.} New Series. NOVEMBER 15, 1839. {Whole No. 346. Vol. IX.

## FUTURE REVENUE OF THE ERIE CANAL.

"We are advocates that great works of national utility should originate with the people; we are inimical, in the highest degree, to legislative interference with anything, from the making of a steam-engine to that of the smallest article; we conceive it is the duty of a wise and a paternal Government to aid and assist public companies in their exertions and endeavors to execute works of public utility: but, on the other hand, if a Government once assumes the mantle of general manufacturer of steam-engines, engineer-general of railroads, &c., under an act of the legislature, then the rights and interests of all the industrious classes are directly invaded, a monopoly set up, and the spirit of enterprise, of invention, and improvement ceases, and all those vigorous trading impulses which have so eminently contributed to the wealth and to the prosperity of all free and enlightened countries."

"'Legislation is not health but human welfare:' and the Government of Great Britain has quite enough to do in legislation for this great empire and the colonies thereunto belonging, without interfereing with projects which should be left entirely to the enterprise of the people under proper legislative restrictions for the good of the public."—*Civ. En. Jour.*

The success of the Erie Canal will be immediately brought forward to show that the above spirited remarks do not apply to this country, all allusion to the failure of the other canals of this State, of Pennsylvania, Ohio, Maryland, etc., being carefully avoided. We will, therefore, examine the causes which have enabled the Erie Canal to pay the ordinary expenses, with interest on cost of construction, as well as the probability of its continuing to do so.

In the first place they were projected by individual sagacity, and it was only by the greatest exertions that they were undertaken by the Government, the question agitating the whole state and forming the test at the polls precisely in the same manner as with the New York and Erie Railroad in the southern counties for the last two years. All the other Canals which have been undertaken by the State *since* the completion of the Erie Canal have, it is true, received the sanction of the legislature, but the people of the State generally did not know, and only too large a majority do not now know that they have incurred a debt of four and a half millions for Canals of which they heard nothing until they were informed that the first appropriations were expended, and that owing to changes in the work from 50 to 200 per cent. additional on the original estimate was required. The Erie and Champlain Canals had, however, other advantages. "If the Erie and

Champlain Canals had been deprived of the benefit of the auxiliary funds, which were originally pledged for the payment of the money borrowed, there would have been a debt against these Canals on the 30th September, 1838, after deducting the surplus of the present year, of $8,459,069. And in this estimate the Erie Canal has all the benefit of the contributions to it in consequence of the construction of the lateral Canals."

"The original cost of the Erie and Champlain Canals, that is, the sum actually expended in constructing them, was $8,401,394 12. Thus it is shown, that in the operation of borrowing, expending and reimbursing the cost of the Erie and Champlain Canals, *confining these works to their own resources*, the *debt* at the end of 21 years would be $57,675 greater than the *whole sum originally expended* in constructing the Canals."

"An estimate made out on the same principle as the one before alluded to, in regard to the finished lateral Canals, shows that without the aid of the treasury or auxiliary resources the Oswego, Cayuga and Seneca, Chemung, Crooked Lake and Chenango Canals, would have been indebted on the 30th Sept., 1838, to the amount of $4,949,182. Add estimated debt of Erie and Champlain Canals as given above, $8,459,069, and it makes a total of $13,408,201."

"This embraces all the finished Canals, 650 miles in extent, and shows the result of the operations of the whole system for twenty-one years, *excluding from the estimate the aid derived from auxiliary funds.* The difference between $13,408,201 and the actual state of all the Canal debts at the close of the fiscal year is $9,851,362, and this is the amount in money and the interest thereon which has been contributed in various ways from the *common fund* of the State to the Canal fund. This is a debt which the Canals owe to the whole people of the State, and which debt the Comptroller, in his report in 1834, proposed to have settled in an *equitable* manner. If this debt had been *adjusted* when the Canals were finished instead of *being used to give a delusive prosperity to them*, it would have furnished a fund which might have been apportioned among the counties and used for roads and other improvements in those sections of the State not adapted to Canals and Railroads, or applied to expenditures of a general character and in which every tax payer has an interest."—[Assem. Doc. No. 4, pp. 27 and 28, Comptroller's Report, 1839.]

We have here a fair account of the manner in which the "delusive statements" of the success of the Erie Canal were got up. If contributions "in various ways from the common fund of the State" had been placed to the credit of the Chenango that hopeful Canal would have paid for itself by this time, though even after that, its income would not equal the amount of ordinary expenses, repairs, and renewals. The case is widely different with the Erie Canal. Having been paid for in a great measure by general taxes on the people of the State, it now yields a large revenue, indeed it has an income sufficient to pay all its expenses with interest on cost of construction, besides appropriating such sums as would in a very few years repay

the original cost. Thus, if the entire nett revenue of the Erie Canal had been applied to liquidating the debt incurred for its construction it would have all been paid off by the end of the year 1850, if we suppose $800,000 per annum to be appropriated to that object; but by that time the debts of the *lateral Canals* would amount to $7,000,000, exclusive of the costs and deficiencies of the Genessee and Black River Canals. Were there no obstacles in the way a considerable increase of tolls would be certain, and under favorable circumstances the nett annual revenue ten years hence might reach or perhaps exceed a million of dollars.

The extreme uncertainty attending any estimate of the future income of the Erie Canal will be very easily demonstrated. The gross income of 1838 was (Sen. Doc. No. 27, 1339,) $1,414,174, towards which "merchandize and passengers" contributed $530,788, or nearly two-fifths of the gross income; a sum considerably *exceeding* the nett revenue of all the Canals for 1838, which was $491,888 (Assem. Doc. No. 4, p. 59,) and not much less than the estimated nett revenue for 1839, $620,000. Now unless the present law restraining the Utica and Schenectady Railroad from carrying freight can be kept in force the Erie Canal must inevitably lose the transportation of merchandize—practically speaking, its entire surplus.

The Empire State as yet does not condescend to enter into competition with her subjects; the farmer is not allowed to send his produce to market except over her highway; the mechanic and the poor man in the cities must render tribute to speculators and capitalists if the thermometer should sink a few degrees lower than usual in November, and thus cut off the supply of the staff of life for the winter; the merchant is forced to send his goods to the West by the way of Philadelphia if expected to reach their destination before summer; and the country merchants and inhabitants generally of the western part of this State are not allowed to receive their supplies by any other *practicable* route. This stupendous monopoly, founded "jure divino," may or may not exist till the Erie Canal pays for itself, but the total abolition of this "peculiar institution" of the State of New-York is eventually certain as the climate of this continent is not favorable to the "divine right." It is not difficult to point out the effects of complete emancipation. Commencing in the spring, the country merchants of this State will have their goods on their shelves, and the western traders will have their merchandize on the shores of Lake Erie by the time the Erie Canal opens, for the present rates of transportation on merchandize will pay well on a Railroad. But the present high rates paid on merchandize enable the forwarder to bring down flour at a very low rate, and if he loses the former he will be under the necessity of greatly advancing the rates on the latter; besides which as the Railroad companies must necessarily be prepared to carry a large quantity of *up* freight they can well afford to bring *down* the flour nearly or quite as low as it can be carried by the Canal. Again, during the winter flour would be carried to Boston

by the Western Railroad and to New York by the Albany Railroad on the slightest advance in value in those cities, and prices would be equalized to a degree attainable by no other means. The Canal, however, would no longer be used for the transportation of that article; the tolls on which

| | |
|---|---|
| amounted in 1838 to . . . . . . . . . . | $277,063 |
| Tolls on merchandize, . . . . . . . . . | 516,686 |
| Passengers, . . . . . . . . . . | 14,102 |
| And we have a grand total of . . . . . . . | $807,851 |

This sum exceeds by 20 per cent. the estimated nett surplus of 1839, which has been already stated to be $620,000, and even slightly exceeds the nett revenue of all the Canals estimated for 1839 ($800,000), supposing the deficiencies of the lateral Canals to be paid by direct taxation.

To show that this estimate is rather under than over what may be expected, the amount of $166,120 has been omitted, though the articles on which it is paid are sufficiently valuable to pay good rates of transportation, and will therefore be commanded by a Railway. They are as follows:

Fur and Peltry, $1,695; Pork, 10,291; Beef, 1,029; Cheese, 4,756; Butter and Lard, 5,773; Wool, 2,132; Wheat, 67,705; Rye, 166; Corn, 2,651; Barley, 19,792; other Grain, 4,521; Cotton, 1,846; Tobacco, 1,067; Clover and Grass Seed, 2,588; Flax Seed, 514; Hops, 270; Domestic Spirits, 7,093; Leather, 708; Furniture, 14,447; Salt, 17,076.—Total, $166,120.

Those who feel disposed to examine more in detail the ground on which the future revenue of the Erie Canal is based will find all the requisite data in the last Reports of the Comptroller and of the Commissioners of the Canal Fund for 1838, and the more thorough their investigation the stronger will be their conviction that the present income of the Erie Canal can only be continued by the stern and unyielding exercise of the might of the State over the right of the citizen. The yoke, however, will not gall much till the completion of the line of Railroads from Albany to Buffalo, very soon after which the exclusive right of the Erie Canal to carry freight will cease to exist. We have all looked with contempt and pity on the revenue and debt of the Government works of Pennsylvania for the last few years, but the day may not be far off which will see the State of New York in a still less enviable situation, from which nothing can save her but the entire abandonment of the system of constructing, under the specious term of "auxiliary Canals," works which never can be required and which never can pay their expenses. This most extraordinary policy is one of the two distinguishing characteristics of the administration of this State for the last eighteen years, and it would appear impossible to conceive any stronger argument against Canals projected and executed by agents of the Government. In Pennsylvania they are already earnestly discussing the project of confining the Government to its legitimate sphere of action, and its consequent withdrawal from

the business of forwarding, dealing in foreign and domestic exchange, constructing Railways, advancing on cotton, building or repairing locomotive or other engines, etc., and judging from the noble stand lately taken by the present spirited and patriotic governor, there is every reason to believe that he will consider no sacrifice too great which may be the means of putting down for ever the vast monopolies of that State, which have eventually proved as injurious to the revenue of the Government as they have been withering in their influence on private enterprise.

It is said that we are here on the eve of a change, and the public works of this State are in that happy condition when a change must be attended with advantages. Still we have no confidence in *any* system of internal improvements under the control of the Government, and have great hopes that the brilliant success which has attended the public works of Massachusetts, all projected, constructed, and managed by private companies, will carry conviction to the minds of all, that individual energy and enterprise are, when untrammelled by the baneful interference of Government, as active in New as in Old England. And why should not the following eloquent remarks apply to the Anglo-Saxon race on this as well as on the other side of the Atlantic?

"Will not the Government of this country read a letter of wisdom from past events? Has not steam navigation across the Atlantic Ocean been achieved in the most satisfactory manner by private enterprise? Have not the river navigations, and also the whole of the canals of England, been executed by companies? Are not all the steam-vessels which cover, not only the British seas, but also those of Europe, entirely due to the successful enterprise of companies? And have not the noblest engineering works in the world been accomplished by private companies? Look at the bridges of Waterloo and Southwark; they will prove that the people are quite capable of executing works as stupenduous and monumental as the pyramids of Egypt, but of a much more useful and noble kind. We are thoroughly convinced that wherever works of a public nature have been executed by the Government, they have not only been inferior to those now named, but they have also been attended with much more expense than if undertaken by private enterprise."

"Looking at France, oue of the most powerful nations of Europe, and where by arbitrary authority the public works of that country had been placed under the control of the State; are those works, we ask, more substantially executed, or kept in a better state of repair than those of Great Britain? Is it not allowed by every person who has travelled through England and Erance, that the roads of the former country are much better than those of the latter, and that the superiority in the velocity of travelling in Great Britain is well known and admitted to surpass that of any other country. It is also remarkable that our bridges, harbours, canals, aye and also our railways, are, we venture to say with pride, the most substantially executed, and the grandest works of the kind that the people of any nation in the world has yet executed. These noble engineering works astonish all travellers who have visited Great Britain; they announce the genius and enterprise of not only a great, but that of a free people, whose unparalleled activity and intelligence have not been fettered and withered by legislative enactments in the promotion of commerce, the increase of our national wealth, and the consequent greatness of this empire: and this may be justly attributed to perfect freedom being allowed to every kind of private enterprise under parliamentary regulation."—*Civ. Eng. Jour.*

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The following vigorous and sensible article, though evidently written in great haste, contains so many excellent remarks that we lay it before our readers with an earnest recommendation to their attention. Of the superiority of railroads as a means of communication, we had conceived that there was no doubt, but legislative documents and frequent remarks in the public prints induce us to believe that the old and ill founded prejudices in favor of Canals (so ably discussed and refuted in the annexed communication) are yet entertained by many who should know better. The facts of the case are determined beyond dispute, and we hesitate not, to challenge

the refutation of the argument derived therefrom. We refrain from further comment, for we are detaining our readers from the article itself.

RAILROADS *destined to supercede canals, in the transportation of merchandize and produce to and from the seaboard to the valley of the Mississippi and the St. Lawrence.*

Railroads, and their capacity to transport merchandize, manufactures and agricultural products of every description, with their importance to the Union, *as a means of defence,* has not been presented in the several relations the subject merits.

In England, France and Holland, as well as in the United States, the first efforts towards internal improvements were directed to canals. France succeeded with her Languedock canal. The Duke of Bridgewater took the lead in England, with the canal which bears his name, whilst Holland with numerous canals, became intersected in every direction; the State of New York, in the face of opposing councils, accomplished the construction of the Erie canal, which has given her the name of Empire State to the Union.

The successful canal policy of this State, was followed by Pennsylvania, Maryland, and Virginia, in their desire to connect their capitals with the valley of the Ohio, without taking into consideration the advantages railways possessed to cross the "back-bone of the United States," the Alleghany mountains. In these States, we find that the talents of their most eminent statesmen were enlisted in favor of canals, prior to the information we now possess of the capacity of a well constructed railroad for transportation. The arguments of able engineers in Europe were first committed to the canal policy from the large private investments in this class of improvements. The advantages of canals, derived from these sources, were presented to the American public in Congressional reports, to prove the great value of canals, and the reverse of the picture for railways was presented, thereby to carry the construction of the Chesapeake and Ohio Canal on a line where a railway from Baltimore to the Ohio is destined to supercede it.

There is some apology for these reports, when we find "*the father of railroads,*" Mr. Wood, took the position, (after the opening of the Stockton and Darlington railroad, upon which, the maximum travelling was then 8 miles per hour,) "It is far from my wish to promulgate to the world the *ridiculous* expectation, or rather profession of the enthusiastic speculatist will be realized, and that we shall see engines travelling at the rate of 12, 16, 18 or 20 miles an hour. Nothing could do more harm than their adoption or general improvement than the promulgation of such *nonsense.*"

It was under these impressions, that the directors of the Liverpool and Manchester railway offered the premium "of 500*l.* sterling for a locomotive capable of drawing after it, day by day, on a well constructed railway or on a *level* plane, a train of carriages of the gross weight of 20 tons, including the tender, at the rate of 10 miles the hour;" more, they did not ask for;

and to show how perfectly they agreed with Mr. Wood, as to the "*nonsense*" of expecting more, they selected this gentleman as one of the judges. In the short space of ten years, what do we find that American enterprize has accomplished with the locomotive engine. Two hundred tons have been carried at this rate of speed on a level, whilst above 700 tons have been moved both by Norris and Baldwin's engines of Philadelphia, at the rate of 3 to 4 miles per hour. On the Boston and Lowell railroad, with grades of 10 feet to the mile, an engine constructed for the Massachusetts Western railroad, has conveyed a train of 63 cars with 333 tons, at the rate of 12 miles to the hour. In fact, such are the improvements in the locomotive, also in the rail, construction and cost of our railways, that even with our sparce population to the square mile, it is now reduced to a certainty, that on such a thoroughfare as the line of the Erie canal, taking into consideration the passenger business, *freight can be transported cheaper by railway than it can be by the " enlarged canal.*"

The period has arrived, and it is high time, that some one ventured to publish it, that, *the main transportation of produce and passengers, from the sea-board to the west, is to be accomplished by railways in preference to canals.* Celerity of motion, with certainty of arrival, *at all seasons of the year,* with the American public, will always command the preference, even were it to cost more for transportation by a railway, which we will not admit will be the case, on such a main thoroughfare, as the line from Buffalo by Albany, to New Yotk.

The consumer will pay an extra charge for transportation by a railway for the first choice of goods. Competition will force rival traders, to supply themselves by this mode of communication two months sooner than the rigor of our climate will allow our canals to open. If this view is correct we come to the conclusion, that hereafter, the rivalry for the early and late trade to and from the west, will be directed mainly to railways, and they must become profitable and indispensable.

It may startle some, and seem perfectlv hetrodox, when we venture to predict, that from this time forward, there will not be found an intelligent legislature, representing the wishes of their constituents, who will vote one dollar towards the construction of any new canal in the State of New York.

We mistake public sentiment, if the expenditures for the *needless* enlargement of the Erie canal, will not have the effect of arresting a work, that it is admitted by all parties, will cost us thirty million of dollars. It has been proved by two tests, lockage and moving tonnage, that the down tonnage has been on the decline for the last five years, from the fact, that the increase of tonnage from agriculture and manufactures does not approximate to the rapid decrease of the tonnage derived from the forrest since the opening of our lateral canals. The Erie canal only gives us, on an average, seven months transportation in a year, over its entire length from Albany to Buffalo.

Boston, we find will soon enjoy a continuous line of railway from her Long Wharf to Buffalo, *the entire year*. Look to the results.

The railroad improvements of Maryland and Pennsylvania give their commercial capitals facilities to approach the valley of the Ohio at all seasons of the year, the effects of which, the city of New York already feels. Our railroads connection with Philadelphia and Baltimore, added to the advantages of the harbor of New York, makes their rivalry less formidable than that of Boston.

It is high time public attention should be directed to the cheapness with which railways can carry freight and passengers, also troops for the defence of the sea-board and the lakes.

It has been satisfactorily tested in Belgium by the late reports of the Chevalier de Gerstner, where the average cost of their railways is $41,000 per mile (double what he finds them to cost on an average in the United States) that *passengers* can be carried with a profit of 5 per cent. nett to the stockholders, at the low rate they charge of 75 cents per passenger per 100 miles. As respects *freight*, we find that "the directors of the Stockton and Darlington railroad have entered into a contract with responsible persons to supply the motive power for this road, at four tenths of a penny or 75 cents per ton per mile." Our population is more scattered than in Europe, but it is believed that one cent (with a passenger business) will pay a profit for conveying one ton one mile.

In the United States our experience in carrying freight is yet limited. In Pennsylvania and Maryland, where the transportation of freight on their railroads is permitted, we find that it is yearly on the increase, with profit to the stockholders.

On the Boston and Worcester railroad, along the line which, there are superior common roads and turnpikes leading into Boston, half the gross receipts of this road, of 44½ miles in extent, during 1838, was $100,292, and for passengers, $112,032. We may ask, what will be the receipts of this railroad, as soon as the line is completed, to take the rich products of the west, centering at Troy and Albany, from the Erie canal, after the Hudson river is closed by ice in November.

By late reports of the legislature of the State of Massachusetts, we learn that the calculations for transportation on their "*Great Western Railway*" from Boston to our State line, at Stockbridge, are upon a large scale. We find that their legislators and scientific men do not consider this improvement, which is to cost $4,200,000 as inferior to the Erie canal, when compared, to promote the interests of their State.

A valuable report from a select committee of both branches of the legislature of Massachusetts, the last winter, took ground, in an able argument to show that the capacity of a *well constructed* railway from Boston to Albany was superior to a canal, and to them "as equal to a second Hudson river, having its source in Albany and termination in Boston." The railroad, they say, "is open for transportation and passengers the *entire* year;

its capacity is not measured by the droughts of summer, nor is its connexion with other sections of our country limited by elevations, to pass which, there is no supply of water for canals. The railway, on the contrary, extends its iron bands of connexion with the whole Union. It is susceptible of extension into every region that our increasing population will require and can support. The ice and snows of winter, are but partial impediments to the daily use of a railroad, whilst canals, on an average, in latitude 43, are closed five months of the year, and this too, at periods when most reqired by the commerce of the country."

The snail's pace of 2½ miles per hour is accomplished by the canals, whilst one locomotive engine can carry from the centre of the city of New York to Buffalo, at the average rate of 10 miles per hour, the usual load of 5 canal boats, (say 150 tons,) of any class of agricultural or manufactured produce, and this too, whilst the Erie canal and Hudson river are frozen up.

It was prejudice and large investments in England that warped their judgments in their reports in 1828 and 9, favorable to canals and adverse to railways. These reports, we repeat, were drawn on largely by our State engineers and canal board in 1835, to prove that a railroad was an improvement to be placed on the medium footing "between a good turnpike and a canal."

This canal mania, led this State to enlarge the Erie canal, and to pass laws for the Chenango, the Black River and the Genesse Valley Canals, over ground, that there is not an intelligent and practical engineer in the United States, but would say, that the interests of the public in transportation and the State in expenditure, would be best promoted by the construction of railways.

The proposed expenditures on the above named canals, which will exceed forty millions of dollars, and (we challenge contradiction to the fact, by a respectable engineer,) will be a burthen to the State, inasmuch as it is now ascertained by experience in Europe as well as in this country, that railways are destined to supecede canals. Such is the genius of the American people with the "go-a-head" principle, so universal in the republic, that nothing can stop their adoption from Maine to Texas, and to all places in the interior.

This is new doctrine to some, but we cannot disguise our opinion, in looking into the vista of time, even at a near period, that railways are to take their rank in advance of canals for *general transportation*, where celerity of motion with certainty of arrival are considered, (as they always will be,) by a commercial people.

As a means of *defence*, railways make the seaboard invulnerable to foreign attack. They will nullify nullification. The rapidity and cheapness of inter-communication will dissipate prejudices adverse to the stability of the Union. With railways, "Mason and Dixon's line" and the distinction of "the southern and western States" is done away with. We shall,

by fostering their construction, be bound together with iron clasps, and "E'Pluribus Unum," will be our motto now and forever.

J. E. B.

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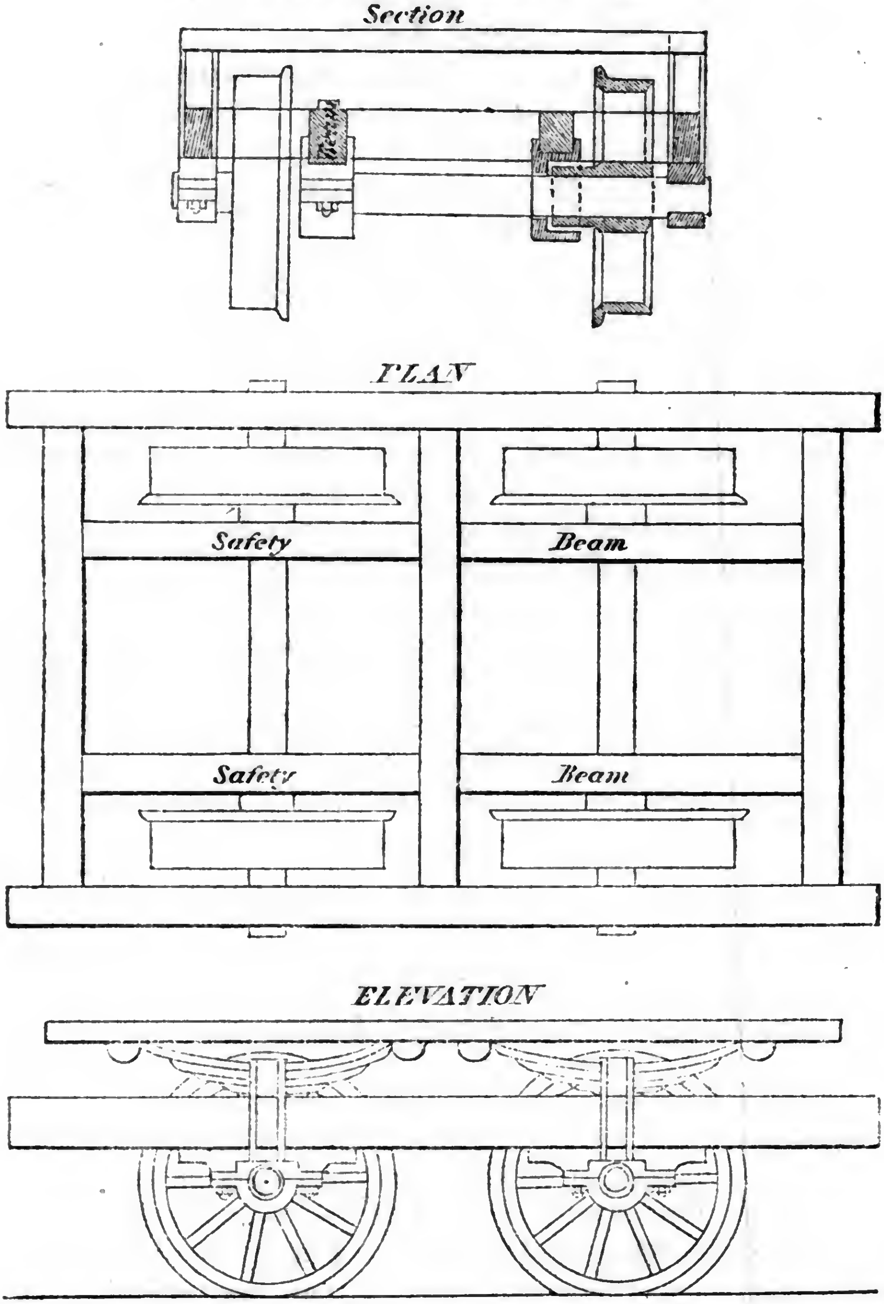
KITE'S PATENT SAFETY BEAM.




In these days of accident and disaster, we heartily welcome every improvement conducing to public safety, and most willingly give place to every new instance of the utility and success of such improvements. We have before called the attention of our readers to Mr. Kite's invention most greatly deserving its title "safety beam." From an examination of the model, which deserves high credit for its great simplicity, and from the

results of an accident which passed under our own observation, and in which we were satisfied that fatal consequences and great danger to the cars were avoided by the fortunate employment of the "safety beam," we were convinced of the great importance of bringing this invention into notice. But as on most of our nothern railroads, the old four wheel cars are still used, we could hardly expect that this improvement or any other of its nature, should be adopted, where such utter disregard was paid to public comfort and safety.

A recent occurrence on the Philadelphia, Wilmington and Baltimore railroad, has added a new testimony to the usefulness of this contrivance. We have seen a certificate from the conductor of the train and superintendant, which gives the following account of the matter:

"On the passage of the evening train of cars from Philadelphia, an axle of one of the large eight wheel passenger cars was from some cause broken, but from the peculiar construction of the cars, called (with truth) the safety beam principle, invented by Mr. Joseph S. Kite, superintendant of the Philadelphia, Germantown and Morristown railroad, the accident was entirely unknown to any of the passengers, or in fact to the conductor himself, until the train, as was supposed, from some circumstances attending the case, had passed several miles in advance of the place where the accident occurred, whereas, had the car been constructed on the common plan, the same kind of accident would unavoidably have much injured the car and perhaps have thrown the whole train off the track, and severely injured if not killed many of the passengers."

It is also stated that "the car, the axle of which was broken, was run from the place where the break was discovered, a distance of *eleven miles*, without any detention, excepting that of removing the passengers to another car, which was deemed advisable, only on account of the friction of the safety hubb, which commences to act immediately on the breaking of an axle."

If this were the only case in which peril of life and limb, to say nothing of damage to cars, had been avoided by the employment of Mr. Kite's contrivance, it would be a good and sufficient reason for advocating the use of it as conducive to public safety. On the contrary, several cases of a similar character are known to have occurred, and the "safety beam" has now become quite common on most of the southern roads. Nearly, if not all of the five cars built of Messrs. Betts, Pusey and Harlan, of Wilmington, Delaware, contain this valuable improvement, and the high reputation of the builders as well as the merit of the invention, have, by means of this happy combination become extensively known.

The miserable policy of adhering to the use of the most antiquated form of four wheel cars, merely because a stock of them has been provided and *must be worn out* before others are purchased, is so short-sighted that it would hardly be thought possible of adoption in an intelligent railroad direction. Yet that such policy has been adopted, and for no other reason,

cannot be denied, as it has been openly acknowledged by railroad companies. How stockholders can patiently see their interest thus mismanaged is more than we can understand. To those companies who, sensible of their great advantages, both in point of comfort, safety and economy, have adopted or are about to adopt the eight wheel car, we most earnestly recommend the use of Mr. Kite's patent safety beam. It is cheap and simple and calculated to increase the confidence of the travelling public, *and if by means of it, one life is saved, its cost is more than repaid.*

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For the information of the writer of the following communication we will state that we had a conversation not long since with Mr. Fessenden in relation to his improved *Rail* and *Chair*, and that he then promised to furnish us with a drawing and description of them for publication, if his other engagements would permit; we will, however, now, in accordance with the request of "An early friend of Railroads"—and we know him to have been such *to his cost*—renew our request to Mr. Fessenden to furnish, at his earliest convenience, the drawings and descriptions called for; and also express the hope that he will readily contribute such other information useful to the cause as his long and successful experience in the construction of Railroads must have furnished him with. We hold that every Engineer and friend of Railroads owes it to the cause to publish facts which his experience may have furnished him with, tending to the improvement of the system.

For the American Railroad Journal and Mechanics' Magazine.

Gentlemen—I find in No. 7, vol. 3, New Series, p. 216, of the Railroad Journal, a Report made by J. M. Fessenden, Esq., Civil Engineer, in relation to the Eastern Railroad in New Hampshire, which I read with pleasure, as it shows that "the times" have not caused a suspension of operations on the eastern railroad from Boston—a link so important in "the *great Atlantic chain*," which, when completed, from the capital of Maine through the principal Atlantic cities to New-Orleans, and from New-Orleans to the great northern lakes and thence back again through the interior to Boston, will serve to unite more closely and more permanently—because it will ensure a more frequent intercourse, and a more intimate acquaintance of the people of this great nation, than *any other* measure which ever has, or probably *can* be adopted.

I have understood that Mr. Fessenden has adopted on this road a rail and chair of an improved form, and was in hopes, when I saw his report, that I should find in it a description of them, but was disappointed in this respect; I will therefore thank you to request him to give a description of his *Rail* and *Chair* for publication in the Journal—the proper medium as I consider it, of communication between the profession and the public, that its superior advantages, if it has any, may be availed of by others.

Your early attention to this request will much oblige one who has read

the Journal from its commencement, and who is as much gratified as you can be to witness its improved appearance under the "new arrangement."

AN EARLY FRIEND OF RAILROADS.

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The following strong testimonial to the merits of American Locomotive Engines, has an additional value in coming from a most accomplished European engineer, who has in person, or by his assistant, examined *every known railroad in the world.* That the Chev. de Gerstner should so heartily recommend the engines of Baldwin, Vail and Hufty, is a sufficient confirmation, if any were needed, of their value. It is already known that two American houses have shipped engines, in compliance with European orders, and we most sincerely hope that the testimonial of Chev. de Gerstner, will increase the demand in Europe. The advantages for which he recommends the engines of Messrs. B., V. and H. are of the utmost value.

"Having visited within ten months nearly all Railroads in the United States, and having collected the most useful information concerning them, which I intend to publish during my further stay of one or two years in this country, I certify with pleasure that I received every where the best testimonials from the Presidents, Engineers and Superintendants of railroads, in regard to the workmanship and the performances of Mr. Baldwin's Locomotives. Owing to the peculiar construction of these engines, I observe that they are remarkably easy to the road, even where light rails are used. I regard them, therefore, after a careful examination of the results obtained, as the best machines used on American railroads, and recommend them strongly to all railroad companies in Europe.

F. A. CHEV. DE GERSTNER.

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Some time since we took occasion to notice a work of Mr. Charles Ellet on the "Laws of Trade." At no period of our progress in Internal Improvement has the necessity for *exact* demonstration upon this subject been so great as at present, and this feature in the work induced us to give it a hearty welcome. We are satisfied that in presenting this work to the profession, Mr. Ellet has determined to submit his labors to the most careful and accurate examination, allowing it to speak for itself, while he is perectly willing to defend his mathematical demonstrations of the "Laws of Trade." In the hope that our engineers will warmly second this first attempt to elucidate a most important, but hitherto unexplored branch of science, we invite their attention to the Card upon our cover.

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We are again indebted to P. G. VOORHIES, Esq., of Wilson's Landing, on Red river, (below Alexandria,) La., for a series of Meteorological tables, continued down to the present time. We value these observations the more highly for being the only data for ascertaining the mean temperature of that part of our country. Mr. Voorhies is entitled to the thanks of the scientific community for his industry in continuing these observations.

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### ECONOMY OF FUEL.

Perhaps there is no subject of more general importance, both in a scientific and a national point of view, than that which forms the title of this

paper, more especially at the present time, when owing to the vast and rapid augmentation of steam power, whether as applied to mines, manufactures, locomotive or maritime purposes, the consumption of fuel has increased to an almost incredible extent. When to these are added the enormous quantity consumed in the iron works, besides that which is annually exported to India, the Colonies, and foreign parts, we cannot but contemplate the probability of the exhaustion of our coal beds (there being no reproduction of coal in this country, since there are no known natural causes in operation to form other beds of it) otherwise than as a national calamity, involving the destruction of a great portion of our manufacturing and commercial prosperity. Nor is the period so very remote when the coal districts, which at present supply the metropolis with fuel, will cease to yield any more. The number and extent of all the principal coal beds in the north of England have been ascertained, and calculations made, by which it would appear that the supply will be probably exhautsed in a period of from 350 to 400 years.

Professor Buckland, in his evidence on this subject, estimates the duration of the coal in these districts, at the present rate of consumption to be 400 years.

Professor Sedgwick, who is well acquainted with the coal strata of Northumberland and Durham, gave his opinion, respecting the duration of the coal of these counties, as follows:—

I am myself convinced, that with the present increased and increasing demand for coal, 400 years will leave little more than the name of our best coal seams.

And he further adds:—

Our northern coal field will probably be in the wane before 300 years have elapsed.

Already this event has occurred in the coal fields of Staffordshire, Warwickshire, and Leicestershire, once amongst the most important in the kingdom, and now nearly exhausted; owing to which cause the manufacture of iron, for which these districts were for a long time celebrated, has been nearly discontinued in those counties, and the chief seat of the iron trade is now removed to Monmouthshire and Glamorganshire; in which two counties alone there are upwards of 100 blast-furnaces for the smelting of iron at present at work, which may be equal to the production of about 400,000 tons of iron a year. Now it is a known fact, that from five to six tons of coal are required for the production of one ton of iron, consequently 2,400,000 tons of coal would be consumed in South Wales in the iron works alone.

The quantity of iron made in Great Britain in the year 1836 is stated in the "Mining Journal," of October 7, 1837, to be about one million of tons, in the manufacture of which six millions of tons of coal would be consumed.

The total consumption of coal in Great Britian in the year 1827 was stated to be 22 millions of tons, and the quantity exported to India, the Colonies and foreign parts about two millions of tons. It is probable, however, that even this amount was considerably under the actual quantity consumed; and if we take into consideration the immense increase that has taken place since that period for the purposes of steam navigation and locomotive engines, we shall probably be considerably under the mark in stating the whole quantity of coal consumed in great Britain, exclusive of that which is exported at 30,000,000 of tons, to which must be added *one-third* of the whole amount, or 10,000,000 of tons, *for coal left and wasted in the mines.* (See "Holme's Treatise on the Coal Mines," who states the waste of small coal at the pits' mouth to be one-fourth of the whole, and

that in the mines one-third.) This enormous proportion of coal left and wasted in the mines seems so incredible as to require some further explanation, and this cannot be better given than in the words of an eminent geologist Dr. Buckland, in his "Bridgwater Treatise," who says:—

We have for many years witnessed the disgraceful and almost incredible fact that more than a million of chaldrons (1,350,000 tons) per annum, being nearly one-third part of the best coals produced by the mines near Newcastle have been condemned to wanton waste, on a fiery heap, perpetually blazing near the mouth of almost every coal pit in that district. This destruction originated mainly in certain legislative enactments, providing that coal in London should be sold, and the duty upon it rated, *by measure* and *not by weight.* The smaller coal is broken the greater the space it fills; it became, therefore, the interest of every dealer in coal *to buy it of as large a size,* and *to sell it of as small a size as he was able.* This compelled the proprietors of the coal mines to send the large coal only to market, and to consign the small coal to destruction.

In the year 1830 the attention of Parliament was called to these evils, and pursuant to the report of a committee, the duty on coal was repealed, and coal directed to be sold by *weight, instead of by measure.* The effect of this change has been that a considerable quantity of coal is now shipped for the London market in the state in which it comes from the pit, that after landing the cargo, the small coal is separated by skreening from the rest, and answers as fuel for various ordinary purposes, as well as mnch of the coal which was sold in London before the alteration of the law.

The destruction of coal on the fiery heaps near Newcastle, although diminished, still goes on however to a frightful extent; that ought not to be permitted, since the inevitable consequence of this practice, if allowed to continue, must be, in no long space of time, to consume all the beds nearest the surface, and readiest of access to the coast, and thus enhance the price of coal in those parts of England which depend on the coal field of Newcastle for their supply: and finally, to exhaust this coal field at a period nearer by at least *one-third*, than that to which it would last, if wisely economised.

The concluding observations of Dr. Buckland, on this important subject, are so much to the purpose, that it will be a sufficient apology for introducing them here. He proceeds thus:—

We are fully aware of the impolicy of needless legislative interference, but a broad line has been drawn by nature between commodities annually or periodically reproduced by the soil on its surface, and that subterranean treasure and sustaining foundation of industry which is laid by nature in strata of mineral coal, whose amount is limited and which when once exhausted is gone for ever. As the law most justly interferes to prevent the wanton destruction of life and property it should seem also to be its duty to prevent all needless waste of mineral fuel, since the exhaustion of this fuel would irrecoverably paralize the industry of millions.

The tenant of the soil may neglect or cultivate his lands, and dispose of his produce as caprice or interest may dictate; the surface of his fields is not consumed, but remains susceptible of tillage by his successor; had he the physical power to annihilate the land, and thereby inflict an irremediable injury upon posterity, the legislature would justly interfere to prevent such destruction of the future resources of the nation.

This highly favored country has been enriched with mineral treasures in her strata of coal, incomparably more precious than mines of silver or of gold. From these sustaining sources of industry and wealth, let us help ourselves abundantly, and liberally enjoy these precious gifts of the Creator;

but let us not abuse them, or by wilful neglect and wanton waste, destroy the foundation of the industry of future generations.

Might not an easy remedy for this evil be found in legislative enactment, that all coals from the ports of Northumberland and Durham, should be shipped in the state in which they come from the pits, and forbiding by high penalties the skreening of any sea borne coals, before they leave the port at which they are embarked. A law of this kind would at once terminate that ruinous competition among the coal owners, which has urged them to vie with each other in the wasteful destruction of small coal, in order to increase the profits of the coal merchant, and gratify the preference for large coals on the part of rich consumers; and would also afford the public a supply of coals of every price and quality, which the skreen would enable him to accommodate to the demands of the various classes of the community.

A farther consideration of national policy should prompt us to consider how far the duty of supporting our commercial interests, and of husbanding the resources of posterity should permit us to allow any extensive exportation of coal, from a densely peopled manufacturing country like our own; a large proportion of whose present wealth is founded on machinery, which can be kept in action only by the produce of our native coal mines, and whose prosperity can never survive the period of their exhaustion.

At the last meeting of the British Association at Newcastle, Dr. Buckland read a paper on the application of small coal to economical purposes, in which he referred to the well known enormous annual waste of coal at the mouths of the various pits near Newcastle, and stated that, owing to what he had said on the subject in his Bridgewater Treatise, the attention of a benevolent individual had been called strongly to the subject. That individual had succeeded in agglutinating the small particles of coal into a firm compact mass, by a process at once simple and cheap; and he believed he had taken out a patent for the method. There would be even an economy in using this coal for many purposes, as it occupied *one-third* or *one-fourth* less space, when packed in boxes, than coal in its ordinary state.—Specimens were exhibited, which had a firm compact appearance, and Dr. Buckland stated that by the direction of government, trials had been made under the inspection of competent persons, and that success had been complete, the combustion being at least as productive as that of coal in its common state.

The experiments alluded to by Dr. Buckland, took place at Woolwich dockyard in August last, under the superintendence of Messrs. Kingston and Dinnen, two experienced engineers. The "prepared fuel," as it was termed, is a composition of skreened coal, river mud and tar, cast into blocks of nearly the size and shape of common bricks. One great advantage attending this form is that a much larger quantity, weight for weight, may be stowed in the hold of a sea going steam vessel, than of common coal, and it is besides not liable to shift its position, like the latter. An engine was worked with this prepared fuel, and the consumption for 6 hours, 45 minutes, was 750 pounds. The same engine required 1,165 pounds of north country coals to keep it going for the same time, showing a saving of 415 lbs. in favor of the prepared fuel.

At another experiment, Welsh coal was used, and 1,046 lbs. were consumed, while 680 lbs. of the prepared fuel easily performed the same work in the same time, It was also remarked that it requird about 50 lbs. less of the prepared fuel to get the steam up, than of common coal, and that the steam was maintained by it at a more even temperature, with very little feeding.

(To be continued.)

**MIXTURE TO PREVENT THE INCRUSTATION OF STEAM BOILERS.—MEMORANDUM**

*Admiralty*, 8*th Jan.*, 1839.

The Lords commissioners of the Admiralty, in calling the particular attention of all officers in command of steam vessels to the annexed abstract of a report from Lieut. Kennedy, late commanding Her Majesty's steam vessel Spitfire, and Mr. Johns, the first engineer of that vessel, are pleased to direct that the mixture therein described, which has been proposed by the latter officer to prevent incrustation on the inner surfaces of boilers, be generally made use of for that purpose in all Her Majesty's steam vessels. The directions as to the proportions of black lead and tallow are to be strictly followed, and the mixture is to be applied as often as circumstances will admit of it, every opportunity being taken as heretofore to remove from the boilers the small deposit which will still be formed.

Report of Lieut. Kennedy and Mr. Johns, engineer of Her Majesty's steam vessel Spitfire.—We beg leave to state that the proportion for a first class steamer should be about sixteen pounds of melted tallow and two of powdered black lead, well mixed and laid on with a common tar brush over the inside of the tubes and fire places, and other inside parts of the boilers that can be got at, every time after a passage of any length, as the more often it is done the better. *The boilers are to be blown out as usual every two hours*, for it is not to be supposed that, without proper attention being paid to this necessary duty, this mixture will prevent the incrustation from forming; the blowing off takes great part of it away while in solution and what remains, after short trips, may be swept off by hand with a piece of oakum; and after long trips, should a thin incrustation remain on the plates, the slightest blow will cause it to fall off in large flakes covered with black lead on the inner side, without the use of the chipping hammer, which only makes the plates rough and more ready to receive and retain the deposit, and otherwise injures the boilers, causing much labor to the men — Ten pounds of tallow and one and a half of black lead would be enough for the smaller steamers after each voyage; or after a very long voyage, that quantity used twice.

The Spitfire ran from Malta to Corfu, from Corfu to Malta, from thence to Gibraltar, and back to Malta, with only one application of the mixture, from want of time.

We consider that the said mixture, if *frequently and properly applied, the same attention being paid to blowing off as before*, will cause the boilers to last at least a *fourth* longer, and will be found a great saving in coals and labor, doing away with the necessity of fresh water, (the Spitfire having had only one supply in her boilers for eighteen months;) and we find that the longer and more often it is used the cleaner the boilers look inside. —*Nautical Magazine.*

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**"DESCRIPTION OF A SAWING MACHINE FOR CUTTING OFF RAILWAY BARS."—BY JOSEPH GLYNN, M. INST. C. E.**

The advantage of having the ends of the railway bars cut as nearly square as possible, that they may truly abut against each other, is so great, that many attempts have been made to effect it. The author in this communication describes the method which is adopted at the Butterfly Works in the manufacture of the rails for the Midland Counties railway. In general the end, rough and ragged as they come from the rolls, are separately reheated and cut off by the circular saw; but accuracy in this case depends on the workmen presenting the bar at right angles to the plane of the saw.

As this cannot be insured, the difficulty may be obviated as follows:—The axis of the saws and the bed of the machine, which is exactly like that of a slide lathe, are placed at right angles with the line of the rolls in which the rails are made; the saws are fixed in headstocks and slide upon the bed, so as to adjust them for cutting the rails to the exact length, and are three feet in diameter and one-eighth of an inch thick, with teeth of the usual size, in circular saws for wood, and make 1,000 revolutions per minute; the teeth are in contact with the hot iron too short a period to receive any damage, but to prevent all risk the lower edge of the saw dips in a cup of water. The saw plate is secured between two discs of cast iron faced with copper and exposed only at the part necessary for cutting through the rail. The rail on leaving the rolls is hastily straightened with wooden mallets on a cast-iron plate, on which it lies right for sawing and sufficiently hot: thus a considerable saving of time, labor and heat is effected. The rail is brought into contact at the same time with the two saws, and both ends are cut off by one operation. If the saws be sharp and the iron hot, the 78 lb. rails are cut through in twelve seconds. The rail on leaving the saws, is placed in a groove planed in a thick cast-iron plate; thus all warping is prevented. The author then describes certain mechanical arrangements, which are exhibited in detail in the drawing accompanying the communication.—*Civil Engineer and Architects' Journal.*

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*Railroad between the Danube and the Black Sea.*—The establishment of a railroad between Tschernowoda and Kostensche, which was to open a direct and speedy communication between the Danube and the Black sea will not be continued this year, or even for some time, and in fact will not be completed till the Porte gives its assent to the project. The marshy ground unfavorable to canalisation has been inspected, and the operation compared with the measurement already made by some Prussian officers in the Sultan's service, but the project of opening a canal appears to be abandoned. The railroad in question is not to go from Tschernowoda, but from Hirsowa, which is at no great distance, to Kostensche, where the rampart or wall of Trajan formerly commenced, a spot famous in ancient history as the place of Ovid's exile. Meantime the railroad in its present state is to be made use of for the transport of goods and provisions. Were the railroad once executed, a distance of more than two days would be gained, and the undertaking would also be of great importance for the trade and navigation of the lower Danube.—*Idem.*

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*Iron Ships.*—The *Ironsides*, the first sailing vessel constructed of iron which has ever crossed the Atlantic, has just returned to Liverpool, with a cargo of cotton from Brazil, after a passage of forty days, though during the whole trip light winds prevailed. This has completely established the practicability of navigating the ocean in ships of iron. The compasses, whose action it was predicted would inevitably be deranged, worked very correctly; and the superiority of the material of which the vessel is built is proved by the fact, that in the course of the whole voyage it was never once necessary to use the pumps. In fact her hull is absolutely water tight. The success of this experiment is highly important, occurring, as it does, at a time when timber is scarce and dear. So little has the *Ironsides* suffered from exposure to wind and weather, that her appearance would induce the belief that she had but lately been launched. Her tonnage is 264;—draft of water aft, 8 ft. 7 in. and forward 8 ft. 3 in. [This is a very important notice, and we commend it to the consideration of our commercial

readers. In the adoption of iron ships several points are to be considered. Economy and durability, we suppose, are in their favor. Their sailing qualities seem by this experiment to be at least equal to those of wooden ships; but these depend less upon the materials of which a vessel is built than upon her model. The thing that strikes us most, however, is the extreme buoyancy of the iron ship. She is said to be 264 tons—we presume by the new mode of admeasurement: if so, she carries probably 400 tons, and yet she draws only about 8 and a half feet of water, or perhaps, with a heavier cargo, nine and a half feet or ten feet at the utmost! Now, the great drawback upon the profit of the coasting trade, at least in this part of England, is the impossibility of constructing a vessel that will carry a large cargo with a draft of water suitable to our tide-harbors. A vessel of 100 tons will draw as much water as this ship; and if the burden be carried up to 150 or 200 tons, the draft of water becomes a serious impediment, and what is gained in freight is lost in frequent and vexatious delays, and in injuries sustained from grounding on bars and sand banks. But a vessel of 100 tons cannot be sailed in winter, and ought not to be sailed at any time, with fewer than four men and a boy; making for four such vessels twenty hands; while such a ship as the *Ironsides* might be salied with twelve or fourteen hands at all seasons. But will an iron ship take the ground with a heavy cargo? That seems to us the principal question; and if it be found that she will—if it be found that a ship of large burden can be so constructed as to be fit for all the purposes of the coasting trade, and capable of enduring the severe trials to which the best and strongest ships are exposed in it, and yet so buoyant as to enter all the Welsh and Cornish ports, at neap tides—if this be ascertained, we may expect in a monht or two, to see half the smiths of Hayle and Neath turned into shipbuiledrs.—*Cornwall Gaz.*

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## PAMBOUR ON THE STEAM ENGINE.

Sir—As you have often, at different times, noticed M. Pambour's works on the steam engine, allow me to direct your attention to his table referred to in page 92 vol. 2 of your Journal. In most cases therein the practical results differ very widely from the theoretical. Now may not this be explained partly by taking into account the gradient immediately before the place of trial, or in other words, the accelerating or retarding force with which it enters it? For instance in the case of the Fury, August 4, 1834 (page 229 of Pambour) it drew 50 tons at 24 miles per hour. Now the theory gives 29 miles; but immediately before the trial plane comes a descending one of . This is omitted in the table.

In example, page 228, the Fury drew 244 tons at six miles per hour. By the theory it could not have moved the load. May this result be attributed to the accelerating force of the plane it had just left, or altogether to the incorrectness of the theory?

I am Sir,

A constant reader.

*London, April* 12, 1839.—*Civ. Eng. and Arc. Jour.*

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Suspension Bridges.—The largest suspension bridge in this country is that across the Menai Strait, with a span of 560 feet; the next in point of size, is that at Montrose, which is 432 feet in span: we have been much gratified by the inspection of a report and plan of a third, which will rival these stupendous works of art, both in magnitude and importance; for while they have but one span each, of the above dimensions, that to which we are alluding projected by that able engineer Mr. J. M. Rendel, will

have two of 450 feet each, and a whole length (with the side openings) between the abutments of 1125 feet. The scite to the proposed bridge, is at Newnham, on the Severn in Gloucestershire, where there is at present a ferry, which has the great inconvenience of being entirely navigable only half an hour before and after high water. The great advantages of such a work will be materially felt in the adjacent country, by the coal and other mines of Dean Forest, becoming easier of access, thereby producing a considerable reduction of price, besides the convenience it will secure of a direct route across the Severn to the southward of Gloucester. The various drawings by which the proposed bridge is illustrated are admirably executed, and convey both in point of topographical, geological and perspective detail, as complete an idea of this magnificent proposed work and its locality as can be expressed by the artist on paper.—*Nautical Magazine.*

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Receipts on the Harlem Railroad.—From October 1st to 25th inclusive, 1839, fare was $7,722 83

From October 1st to 20th inclusive, 1838, fare was 5,621 16

$2,101 67

Increase in the last 20 days, over the corresponding period of last year $2,101 67, equal to $105 per day, or 37¼ per cent increase.

The number of passengers carried on the 15th street line, from 1st to 20th of October inclusive, was fifty six thousand two hundred and sixty five, at six cents each.

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## LOCOMOTIVE ENGINES.

We give the following communication from the Pennsylvania Enquirer with pleasure—as we do all similar accounts of "improvements of this particular breed of *horses*"—and we do it the more readily, as it affords us an opportunity again to call attention to the eminent success of the gentlemen therein named, in their efforts to "improve the breed;" and to express the opinion that more real and valuable improvement has been made in this "breed," *in the locomotive shops* of the United States within the last *seven* years, than has been effected in the old fashioned horse by all the "race courses" in the Union in fifty years.

Mr Editor:—My attention was directed to-day to a new Locomotive Steam Engine, manufactured for the Philadelphia, Germantown and Norristown Railroad Company, by Messrs. Baldwin, Vail & Hufty, the extensive manufacturers on Broad street. The engine has been in use several days, and performs to the entire satisfaction of both makers and owners.

The peculiarity in the arrangement is, that there is no frame around the boiler, and none is required. The machinery is attached to the naked boiler—is all outside of the wheels, directly under the hand and eye of the engineer, and is of that simple and permanent arrangement so peculiar to all of Mr. Baldwin's designs. I had supposed that little room was left at this time for simplification and improvement in Locomotive Engines, but shall not be at all surprised after this, to learn that Mr. Baldwin has pruned the little left of former English arrangements, in his locomotives. No person can examine this machine and not feel proud of her as a specimen of American skill, both in the design and the mechanical execution of the work. I have seen many engines of English and American manufacture

and do not hesitate to say that this is the most perfect piece of work I ever examined. She is named "Fort Erie," and appears, by the plate on her side, to be the 138th engine built in Baldwin's shop. Much credit is due Col. Watmough the President of the company for his indefatigable exertions in behalf of the stockholders and the public, in procuring good and efficient locomotives, and in the general improvement of the condition of the road. I have observed, with much pleasure, that every thing is carried on under his own personal direction and inspection; and do not believe that any rail road in this country is possessed of better machinery and accommodations and more obliging agents and officers. I am not a stockholder, or in any way interested in the work, but deem the above remarks due to merit.

ONE OF THE PEOPLE.

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*Steamers from the Clyde to New York.*—A joint stock company is now forming in Glascow, for carrying passengers and merchandise between the Clyde and New York, by means of an iron steam ship of great power and capacity, to sail at the rate of at least sixteen miles an hour, thereby making a passage in about ten days, and enabling this vessel to make a monthly voyage to America. The capital to be 50,000*l*.—*Glasgow Chronicle.*

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## THEORY OF THE STEAM-ENGINE.

### CHAPTER I.—PROOFS OF THE INACCURACY OF THE ORDINARY MODE OF CALCULATION.

(Continued from page 287.)

The regulator, then, can make no change in the pressure in the cylinder, but this is what happens. The quantity of steam of a given density, which flows through a determined orifice, being in proportion to the area of that orifice, it follows that when the opening of the regulator is contracted, the *quantity* of steam, at the pressure of the boiler, which passes into the cylinder, is thereby diminished; nevertheless the same quantity is still generated in the boiler. The steam which has ceased to find an issue towards the cylinder, will then accumulate in the boiler, and will there rise to a greater and greater density and elastic force, till at length it finds an issue somewhere; till for instance, having attained the pressure necessary to raise the safety valves, it escape into the atmosphere. Then a balance will be established, according to which the surplus of steam generated above what can reach the cylinder, will find a constant issue by the safety valves; and the rest will pass through the orifice of the regulator and go into the cylinders to produce the motion of the piston. From this moment all will persevere in the same state, and the pressure in the boiler will continue as high as it must be, to keep the safety-valve open and give egress to the steam, as quickly as it is produced.

Hence it is plain that the contracting more or less of the regulator can have no action on the pressure in the cylinder, but that it has a very direct action on the pressure in the boiler.

2. We have just said that, according as the aperture of the regulator is contracted, the pressure of the steam will rise in the boiler and its density increase at the same time; and so long as the steam shall not find an opening to escape entirely as fast as it is produced, this increase of density and elastic force will continue; for we suppose that the same mass of steam per minute is still generated in the boiler, and that the fire is maintained in the same state. Now the steam is retained in the boiler by two obstacles; the orifice of the regulator which opposes its passage on account of the density,

and the safety-valve which opposes its passage on account of the pressure. Two cases then may now occur, according to which of the two obstacles shall give way first; either the steam becoming more and more dense, will in the end so reduce its volume, as to issue entirely by the orifice of the regulator, notwithstanding the contraction of the latter; or else the safety-valve, opposing less resistance to the elastic force than the narrowed orifice opposes to the density, the steam will escape by the safety-valve.

In the first of these two cases, then, the engine will be thus regulated: in the cylinder, as invariably, the pressure of the resistance; and in the boiler the pressure necessary for the corresponding density of the steam, to admit of its issuing entirely by the aperture afforded by the regulator.

And in the second case, the engine, on the contrary, will be thus regulated; in the cylinder still the pressure of the resistance, and in the boiler that of the safety-valve.

We must now consider separately each of these cases. Let us suppose that the safety-valve being set at a very high pressure, and the orifice of the regulator, on the contrary, being *but moderately* contracted, the steam accumulating in the boiler, has acquired the density which allows its issue by the orifice, before it has acquired the pressure which procures its escape by the safety-valve. Then it will happen that the *total* quantity of steam produced will pass into the cylinder, that it will there assume the pressure of the resistance, dilating itself in proportion; and by dividing the volume of the steam thus dilated by the area of the cylinder, we shall always have the velocity of efflux by the cylinder, which is nothing else but the velocity of the piston. Thus all will go on as before in the engine, and consequently the effects produced will always be given by the same formulæ, P being made of course to express the new pressure produced in the boiler, and S the new vaporisation, if that vaporisation has changed in consequence of the change of pressure.

Let us now suppose that the safety-valve is set at a low pressure, and that the regulator, on the contrary, is considerably contracted; so that the steam rises the valve before it acquires the density that would permit it to issue entirely by the regulator. The valve will then be raised, and a part of the steam which continues to be generated in the boiler, will be lost in the atmosphere; and necessarily the effects of the engine will be by so much diminished. But let it be observed, that, with respect to that part of the steam which is not lost, that is the part which finds an issue towards the cylinder, it may always be truly said, that it will there assume the pressure of the resistance, and act in the same manner as the total mass of the steam did before.

The only difference will be then, that the effects produced, instead of being due to the *totality* of the steam, will now be due to a portion only of that steam.

Thus, provided our formulæ take account of this difference, they will thereby take into account the whole change that has taken place. Now this is precisely what they do, for we have said that the quantity S, in those formulæ, represents the *effective* vaporisation of the engine, that, in fact, which is really transmitted to the cylinders; or, in other words, the *total* vaporisation, minus that which is lost by the safety-valve. It will, then, suffice to substitute for S the real value proper to the case, and the formulæ will continue to represent what passes in the engine.

As the *total* quantity of water evaporated in a given time is measured directly in the feeding apparatus, all that remains to be sought is the means of estimating that which is lost by the safety-valve, in order to subtract it from the former. This valuation is easily made, by noting how much the

valve is raised at the moment of the loss, which the length of the valve-levers, and the graduated scale with which they are furnished, render very easy to do; afterwards the regulator must be completely closed, so as to force the whole of the steam produced to escape by the valve, and note taken again of the degree of elevation which this will cause to the valve. Then the proportion of the first elevation to the second will give the ratio of the steam lost to the whole steam produced. This is the means we have employed for locomotives. Should this valuation not appear sufficiently precise, the waste steam may be condensed in a separate vessel, and the quantity of water measured. It will always, then, be easy to know the *effective* vaporisation of the engine, and consequently, by introducing it into the formulæ, we shall continue to have the true effects produced.

In the two preceding cases we have supposed that the boiler continues, after the contracting of the regulator, to produce the same quantity of steam. A third case, however, may occur, namely, that wherein the engineer shall lower the *damper*, the moment he sees the valve blow, and reduce his fire so as to stop the blowing of the valve. Then the mass of steam produced per minute will diminish; but since it is clear that the quantity which is produced, however small it may be, will always act in the engine in the same manner it follows that, provided we substitute this new evaporation in the formulæ, we shall have also the new corresponding effects. Thus, for this third case as for the other two, the formulæ will always satisfy the exigencies, as soon as the substitutions proper to the supposed case shall have been made.

3. It will now be proper to examine what changes the effects of the engine will undergo in the three preceding suppositions. We have seen that the proposed formulæ will always give those effects, on the proper substitutions being made in them. Let us then examine the results of those substitutions.

In the first case, to wit, the fire continued at the same degree of intensity, and the orifice narrowed, though not sufficiently to make the valve blow, the pressure P in the boiler becomes greater. But in the exposed formulæ, the pressure P figures only as multiplied by $m$, which is the *relative* volume of the steam. This volume being inversely as the density, and the density itself varying very nearly in the direct ratio of the pressure, it follows that, unless a very great change of pressure take place, the product $m$ P will remain constant. If it be supposed, as is generally admitted, that the evaporation of a given boiler is the same under different pressures of the steam, the quantity S will not vary either. In this case, then, the formulæ will give the same results; and consequently the engine will produce the same effects, after the contracting of the regulator as before that contraction was made.

In the second case, to wit, contraction of the regulator, attended with blowing of the safety-valve, there is still increase of pressure in the boiler, which, as we have just seen, produces no change in the effects. But moreover there is a certain loss by the safety-valves, and that loss diminishes by so much the *effective* vaporisation S. There will then be a diminution of effect precisely proportional to the quantity of steam lost by the valve, which we have given the means of measuring.

Finally, in the third case, to wit, contraction of the regulator, accompanied by a reduction of the intensity of the fire, the blowing of the safety-valve will be suppressed only by producing a smaller mass of steam in the boiler. But since this mass of steam, generated and transmitted to the cylinders, is less than before the contraction of the regulator, it follows that the effect produced by the engine, or the result given by the formulæ, will

be reduced just so much. Thus this third case is similar to the second, and will similarly be attended with a reduction of effect.

The first of the three cases which we have just presented, takes place without the smallest attention being paid to it, whenever the orifice of the regulator is but slightly diminished.

The second occurs almost continually in locomotive engines, because these having to overcome very variable resistances, according to the inclinations of the road they traverse, it is necessary to maintain an intense fire, and to keep the engine always ready to develope on an emergency an increase of power.

The third is that which happens generally in stationary engines, when the regulator is pretty much contracted, because the regulator, in those engines, being never reduced but when the work of the engine requires less force, the engine man takes advantage of that circumstance to diminish the intensity of the fire, and to produce no more evaporation than what is strictly necessary.

These three cases may then occur in the different engines, but the exposed formulæ will always adapt themselves to them.

### *Section VIII.—Of the differences which exist between the theory proposed and the ordinary theory.*

In terminating the general exposition of our manner of viewing the action of steam in steam-engines, we will resume in a few words the differences existing between the method we propose and that which has been in use hitherto.

1. The ordinary theory passes from the theoretic effects to the practical by means of a constant coefficient.

Ours rejects entirely the use of that coefficient, which we regard as resulting from a fundamental error in the calculation of what are termed the theoretic effects.

2. The ordinary theory acknowledges not knowing the pressure in the cylinder; it seeks to deduce it from that of the boiler.

Our theory determines, *a priori*, the pressure in the cylinder, as being, not equal nor proportional to that of the boiler, but equal to that of the resistance on the piston.

3. The ordinary theory determines the load which an engine is capable of drawing, without taking the velocity into the calculation. That is to say, it maintains that the engine will always draw the same load at any velocity that can be imagined.

Our theory brings the velocity into the calculation in such sort, that the greater the velocity the less will be the load the engine can draw.

4. The ordinary theory calculates the evaporation of the engine for a resistance and a velocity given, exclusively of any consideration of the resistance; that is to say, it maintains again that the evaporation necessary to effect the motion shall be independent of the resistance to be moved.

Ours, on the contrary, introduces the load and the velocity into the calculation.

5. The ordinary theory has no means of calculating the velocity that an engine will assume with a given resistance.

Ours gives this calculation with the same simplicity as the preceding.

6. The ordinary theory regards the regulator as determining the pressure in the cylinder. And yet in that calculation it takes no account of the variations of the regulator.

Ours regards the regulator as fixing the pressure in the boiler and not in the cylinder. It introduces the effects of the regulator into the formulæ.

7. The ordinary theory is but an approximation more or less exact.

Ours, on the contrary, which will be seen still more developed, is a method completely analytic in all its parts.

Nothing then can be more distinct than these two methods; and as, not only since the year 1835, when we first laid down these principles in our *Treatise on Locomotive Engines*, but even as late as December, 1837, the authors who have treated these questions, whether in their writings or in their public lectures, have employed the method of coefficients, we think that the recapitulation we have just made sufficiently establishes that their conception of these questions is altogether different from our own.

We do not then deem it necessary to insist any more on this subject, and shall now pass on to the complete development of the formulæ, of which we have as yet given but a general outline.

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## CHAPTER II.

### OF THE LAWS WHICH REGULATE THE MECHANICAL ACTION OF THE STEAM.

*Section I.—Relation between the temperature and the pressure of the steam in contact with the liquid.*

Before entering upon considerations which have for their basis the effects of the steam, it may be necessary to lay down in a few words, some of the laws according to which the mechanical action of the steam is determined or modified.

In the calculation of steam engines it is requisite to consider four things in the steam.

Its *pressure*, which is also called tension or elastic force, and which is the pressure it exercises on every unit of the surface of the vessel that contains it.

Its *temperature*, which is the number of degrees marked by a thermometer immerged in it.

Its *density*, which is the weight of a unit of its volume.

And its *relative volume*, which is the volume of a given weight of steam compared to the volume of the same weight of water, or, in other words, to the volume of the water that has served to produce it. We deem it necessary to add here the word *relative*, in order to avoid the confusion which would otherwise arise continually between the absolute volume filled by the steam, which may depend on the capacity of the vessel that contains it, and the relative volume which is the inverse of the density. Thus, for instance, steam generated under the pressure of the atmosphere may fill a vessel of any size, but its relative volume will always be 1700 times that of water.

When the volumes occupied by the same weight of two different steams are compared together, it is evidently a comparison of what we call the relative volumes of those two steams. For, the two steams compared having the same weight, correspond to the same volume of water evaporated. But the relative volume of the steam is the quotient of the absolute volume of the steam by the corresponding volume of water. Therefore, it follows that the ratio of the relative volumes of the two steams is the same as the ratio of their absolute volumes; and this proposition must be kept in mind for what will follow hereafter.

The steam may be considered at the moment of its generation in the

boiler, when still in contact with the liquid from which it emanates, or else as being separated from that liquid.

When the steam, after having been formed in a boiler, remains in contact with the generating water, it is observed that the same temperature corresponds invariably to the same *pressure*, and *vice versa*. It is impossible then to increase its temperature, without its pressure and density increasing spontaneously at the same time. In this state the steam is therefore at its *maximum density and pressure for its temperature*, and then a constant connexion visibly exists between the temperature and the pressure.

If on the contrary the steam be separated from the water that generated it, and that the temperature be then augmented, the state of maximum density will cease, since there will be no more water to furnish the surplus of steam, or increase of density, corresponding to the increase of temperature. That invariable connexion above mentioned, between the temperature and the pressure, will then no longer exist, and, by accessory means, the one may at pleasure be augmented or diminished, without any necessity of a concomitant variation taking place in the other, as it happens in the case of the maximum density.

It is necessary then to distinguish between these two states of the steam.

One of the most important laws on the properties of steam, is that which serves to determine the elastic force of the steam in contact with the liquid, when the temperature under which it is generated is known; or, reciprocally, to determine that temperature when the elastic force is known. Not only this inquiry is of a direct utility, but we shall see in the sequel, that it serves equally to determine the density or relative volume of the steam formed under a given pressure, a point of knowledge indispensable in the calculation of steam-engines.

Experiments on this subject had long been taken in hand, and they were very numerous for steam formed under pressures less than that of the atmosphere; but for high temperatures, the experiments extended but to pressures of four or five atmospheres. Some few only went as far as eight, and that without completing the scale in the interval. The extreme difficulty of researches of this kind, if made with proper attention, the heavy expenses they occasion, and the danger attending them, had prevented the experiments from being carried farther. But to the Academy of Sciences of the Institute of France we are indebted for a complete table on this subject. The academy confided the conduct of these delicate experiments to two distinguished scientific men, Messrs. Arago and Dulong, who evinced in them every nicety that a perfect knowledge of the laws of natural philosophy could suggest, to avoid the ordinary causes of error. Never were researches of this kind conducted on so vast a scale, nor with more accuracy. The pressure of the steam was measured by effective columns of mercury contained in tubes of crystal glass, which together extended to the height of 87 feet English. The instruments were constructed by the most skilful makers, and no expense was spared.* Therefore the greatest degree of confidence is to be attached to their results.

These beautiful experiments furnish a series of observations, from the pressure of 1 atmosphere to that of 24. To form however a table extending beyond this limit, Messrs. Dulong and Arago have sought to deduce from their observations a formula which might represent temperatures for still higher pressures without any noticeable error. They have in fact attained

* Vide Exposé des recherches faites par ordre de l'Académie des Sciences, pour determiner les forces élastiques de la vapeur d'eau à de hautes températures. *Memoires de l'Académie des Sciences*, Tome X.; *Annales de Chimie et de Physique*, Tome XLIII. 1830.

that end, by means of a formula which we shall presently report, and whose accord with experience is such, for all that part of the scale above four atmospheres, as to give room to think that, on being applied to pressures up to 50 atmospheres, the error in temperature would not in any case exceed 1 degree of the centigrade thermometer or 1·8 degree of Fahrenheit. They were enabled then, as well from the result of their observations as by means of that formula, to compose a table of temperatures of steam up to 50 atmospheres of pressure, with the certainty of committing no error worthy of note.

Though the formula of Messrs. Arago and Dulong may be applied to pressures comprised between 1 and 4 atmospheres, with an approximation that would suffice for most of the exigencies in the arts, they did not indicate the use of it for that interval, because in that part of the scale, other formulæ already known accord more exactly with the results of observation, and ought, in consequence, to be preferred. Among those formulæ, that originally proposed by Tredgold, and afterwards modified by his translator, Mr. Mellet, gave the most exact results; and no inconvenience arises from the use of it, when it is required merely to compose a table by intervals of half atmospheres. But as, for the more commodious use of the formulæ which we have to propose in this work, we shall want to establish a table by intervals of pounds per square inch; we deem it better to employ a formula which we shall give with the others presently, and which, approaching as near as that of Tredgold to the results of direct observation, in the points furnished by experiment, has moreover the advantage of coinciding exactly at 4 or 4½ atmospheres with the formula of Messrs. Dulong and Arago, which is to form the continuation of it.*

These formulæ, as well as other similar ones, have the inconvenience of suiting only a limited part of the scale of temperatures. That of Tredgold modified, as well as that which we propose to substitute for it, represent very closely the observations for the interval between 1 and 4 atmospheres; but below that point they are incorrect, and above it they are inferior in point of accuracy to that of Messrs. Dulong and Arago.

The latter accords remarkably with the facts, from 4 atmospheres to 24. In this interval its greatest difference with observation is ·4 degree of the centigrade thermometer or ·7 of Fahrenheit, and nearly all the other differences are only ·1 degree centigrade or ·18 Fahrenheit; but, as we have already said, it begins to deviate from the observation below 4 atmospheres.

Finally, among the formulæ proposed by different authors on the same

* In fact, comparing, in French measure, the two formulæ with the observation, we find the following results, as it will be easy to verify hereafter.

| Elastic force in atmospheres. | Observed temperature | Temperature given by Tredgold's form. modified by Mellet. | Temperature given by the proposed formula. | Temperature given by the form. of Messrs. Arago and Dulong. |
|---|---|---|---|---|
| 1 | 100· | 99·96 | 100 | ,, |
| 2·14 | 123·7 | 123·54 | 123·34 | ,, |
| 2·8705 | 133·3 | 133·54 | 133·17 | ,, |
| 4· | ,, | 145·43 | 144·88 | ,, |
| 4·5735 | 149·7 | 150·39 | 149·79 | 149·77 |

It appears that the formula which we propose differs from the observed temperatures nearly as much as that of Tredgold modified; but as the difference from the observation is on the *minus* side instead of the *plus*, there results a coincidence at 4½ atmospheres with that of Messrs. Arago and Dulong.

subject, that of Southern is very suitable to steam formed under pressures inferior to that of one atmosphere; it deviates then from the truth only in very low pressures, as appears from the experiments of that engineer. But for pressures superior to 1 atmosphere it ceases to have the same accuracy: from 1 to 4 atmospheres it gives more error than that of Tredgold modified, and above 4 atmospheres the error rises rapidly to 1 and 1·5 degree of the centigrade thermometer, or 1·8 and 2·6 degrees of Fahrenheit; so that the formula of Messrs. Arago and Dulong, which is, besides, of more easy calculation, becomes then far preferable to it.

No one then of these formulæ suits the whole series of the scale of temperatures, and to hold exclusively to any one of them would be knowingly to introduce errors into the tables. As moreover, the true *theoretic* law which connects the pressures with the temperatures is unknown, and that these formulæ are formulas of interpolation, established solely from their coincidence with the facts, and used merely to fill up the intervals of the experiments, according to what is wanted for the regular division of the tables, the only means of making use of them is to apply each respectively to that portion of the series which it suits. Then, from the comparison of their results with experience, one may rest assured that the error on the temperature will in no point exceed seven-tenths of a degree of Fahrenheit, or four-tenths of a degree of the centigrade thermometer. This was the means employed before us, and we shall adopt it in the formation of the tables we are about to present.

The formulæ, which will serve to compose these tables, are then the following, which we report here, not in their original terms but transformed, for greater convenience, into the measures usual in practice; that is, expressing the pressure $p$ in pounds per square inch or in kilograms per square centimetre, and the temperature $t$, in degrees of Fahrenheit's or of the centigrade thermometer, reckoned in the ordinary manner.

Southern's formula, suitable to pressures less than that of the atmosphere (French measures):

$$p = \cdot 0034542 + \left(\frac{46\cdot 278 + t}{145\cdot 360}\right)^{5\cdot 13},$$

$$t = 145\cdot 360 \sqrt[5\cdot 13]{p - \cdot 0034542} - 46\cdot 278.$$

Tredgold's formula modified by Mr. Mellet, suitable to pressures of 1 to 4 atmospheres (French measures):

$$p = \left(\frac{75 + t}{174}\right)^{6},$$

$$t = 174 \sqrt[6]{p} - 75.$$

(3) Formula suitable, like the preceding, to pressures from 1 to 4 atmospheres (French measures):

$$p = \left(\frac{72\cdot 67 + t}{171\cdot 72}\right)^{6},$$

$$t = 171\cdot 72 \sqrt[6]{p} - 72\cdot 67.$$

Formula of Messrs. Dulong and Arago, suitable to pressures from 4 to 50 atmospheres (French measures):

$$p = (\cdot 28658 + \cdot 0072003\, t)^{5},$$

$$t = 138\cdot 883 \sqrt[5]{p} - 39\cdot 802.$$

Southern's formula, suitable to pressures less than that of the atmosphere (English measures):

$$p = \cdot04948 + \left(\frac{51\cdot3+t}{155\cdot7256}\right)^{5\cdot13},$$

$$t = 155\cdot7256 \sqrt[5\cdot13]{p - \cdot04948} - 51\cdot3.$$

Tredgold's formula modified by Mr. Mellet, suitable to pressures from 1 to 4 atmospheres (English measures):

$$p = \left(\frac{103+t}{201\cdot18}\right)^{6},$$

$$t = 201\cdot18 \sqrt[6]{p} - 103.$$

Formula suitable, like the preceding, to pressures from 1 to 4 atmospheres (English measures):

$$p = \left(\frac{98\cdot806+t}{198\cdot562}\right)^{6},$$

$$t = 198\cdot562 \sqrt[6]{p} - 98\cdot806.$$

Formula of Messrs. Dulong and Arago, suitable to pressures from 4 to 50 atmospheres (English measures):

$$p = (\cdot26793 + \cdot0067585\, t)^{5},$$

$$t = 147\cdot961 \sqrt[5]{p} - 39\cdot644.$$

Besides the formulæ which we have just reported, there exists another proposed by Mr. Biot, which, compared by that illustrious natural philosopher to the above-mentioned experiments on high pressures, to those of Taylor on pressures approaching nearer to 100 degrees centigrade. and to a numerous series of manuscript observations made by Mr. Gay-Lussac, from 100° to —20 degrees centigrade, reproduces the results observed, with very slight accidental deviations, such as the experiments themselves are liable to. This formula, which has consequently the advantage over the preceding, of being applicable to all points of the scale, is the following:—

$$\log p = a - a_1\, b_1{}^{20 \times t} - a_2\, b_2{}^{20 \times t}.$$

Log $p$ is the tabulary logarithm of the pressure expressed in millimetres of mercury at 0° centigrade; $t$ is the centesimal temperature counted on the air thermometer, and the quantities $a$, $a_1$, $a_2$, $b_1$, $b_2$, are constant quantities which have the following values:

$$\begin{aligned} a &= 5\cdot96131330259, \\ \log a_1 &= \bar{1}\cdot82340688193, \\ \log b_1 &= -\cdot01309734295, \\ \log a_2 &= \cdot74110951837, \\ \log b_2 &= -\cdot00212510583. \end{aligned}$$

This formula cannot fail to be extremely useful in many delicate researches on the effects of steam; but to establish, by its means, a table of the form we require, the pressure ought first to be deduced from it for each degree of the air thermometer; then these degrees ought to be afterwards changed into degrees of the mercury thermometer; and as this would not givet he temperatures corresponding to given pressures, by regular intervals, a subsequent interpolation would be still necessary to make the table in the proper disposition. These long operations induced us to give the prefer-

ence to the previously cited formulæ, for the construction of the tables which we shall shortly present.

*Section II.—Relation between the relative volumes and the pressures, at equal temperature, or between the relative volumes and the temperatures, at equal pressure, in the steam separated from the liquid.*

We have said that when the steam is in contact with the generating liquid, its pressure is necessarily connected with its temperature; and as the density of an elastic fluid depends only on its temperature and its pressure, it follows that the density is then always constant for a given temperature or pressure. But when the steam is separated from the liquid, that connexion between the temperature and the pressure no longer exists. The temperature of the steam may then be varied without changing its pressure, or reciprocally; and according as the one or the other of these two elements is made to vary, the density of the steam undergoes changes which have been an object of investigation among natural philosophers.

One very remarkakle law in the effect of gas and steam is that which was discovered by Mariotte or Boyle, and has since been confirmed, as far as to pressures of 27 atmospheres, by Messrs. Arago and Dulong. It consists in this, that if the volume of a given weight of gas or of steam be made to vary without changing its temperature, the elastic force of the gas will vary in the inverse ratio of the volume it is made to occupy. That is to say, if $v$ and $v'$ express the volumes occupied by the same weight of steam, and $p$ and $p'$ the pressures which maintain the steam compressed under those respective volumes, the temperature, moreover, being the same in both cases, the following analogy will exist:

$$\frac{p}{p'} = \frac{v'}{v}.$$

And therefore, $\mu$ and $\mu'$ being the *relative* volumes of the steam at the pressures $p$ and $p'$, we shall have

$$\frac{p}{p'} = \frac{\mu'}{\mu}.$$

According to this law, if a given weight of an elastic fluid be compressed to half its primitive volume, without changing its temperature, the elastic force of that fluid will become double. But it is plain that this effect cannot take place in the steam in contact with the liquid, because it supposes that during the change of pressure the temperature remains constant, whereas we have seen that in such state the pressure always accompanies the temperature, and *vice versa.*

Another property equally important in the appreciation of the effects of steam has been discovered by a celebrated chemist of our times, Mr. Gay-Lussac. It consists in this, that if the temperature of a given weight of an elastic fluid be made to vary, its tension being maintained at the same degree, it will receive augmentations of volume exactly proportional to the augmentations of temperature; and for each degree of the centigrade thermometer, the increase of volume will be ·00364 of the volume which the same weight of fluid occupies at the temperature zero. If the temperatures are taken from Fahrenheit's thermometer, each augmentation of 1 degree in the temperature will produce an increase of ·00202 of the volume occupied by the fluid at the temperature of 32°

If then we call V the volume of the given weight of the elastic fluid, under any pressure, and at the temperature of 32 degrees of Fahrenheit, the

volume it will occupy under the same pressure, and at the temperature $t$ of Fahrenheit will be

$$v = V + V \times \cdot 00202\,(t - 32).$$

It follows that, between the volumes $v$ and $v'$ occupied by the same weight of steam, at the same pressure and under the respective temperatures $t$ and $t'$, there will be the following analogy:

$$\frac{v}{v'} = \frac{1 + \cdot 00202\,(t - 32)}{1 + \cdot 00202\,(t' - 32)},$$

which will also be true, when we replace the ratio of the two absolute volumes $v$ and $v'$, by the ratio of the *relative* volumes $\mu$ and $\mu'$ of the steam.

This law, supposing that the temperature of the steam changes, without the pressure undergoing any change, obviously cannot apply to the effects produced in steam in contact with the liquid, since in those the pressure changes necessarily and spontaneously with the temperature.

(To be continued.)

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THE PATENT ROTATIVE DISC ENGINE.—Mr. Whishaw having been requested to examine and report on the principle of construction of the rotative disc engine, and to institute a comparison between it and those of the reciprocating kind, devoted a week to the purpose, and examined six different engines, the whole of which were represented by the parties at whose works they are in use, to have performed their duties most satisfactorily. One of these engines (Mr Whishaw observes) has been working for fifteen months, and has only required during this period the expenditure of three shillings for repairs. Mr. Whishaw continues:—"The advantages to be derived from a rotative engine of simple construction, yet producing a mechanical effect, equal to one on the reciprocating principal, at much less original cost, and with less expenditure of fuel, must be obvious to every one. Such a machine has long been a desideratum amongst engineers. The attempts which have hitherto been made to accomplish this desirable object, so far as my knowledge extends, have failed, either from the motion of the various parts of the machine being such as to produce so great an amount of friction, and consequently, of rapid destruction; or from the engines requiring a greater supply of steam to effect a given amount of work. In my examination, therefore, of this invention, I have particularly directed my attention to these two important points. As regards the first, I find the moving parts of this engine are so few in number, and their motion so uniform and regular, that the amount of friction must be very materially reduced; the wear, therefore, of these moving parts, and their liability to derangement, will be reduced in a proportionate degree. This opinion is fully borne out by the examination I have made of several engines, which have been in operation for a considerable time; some of these were taken to pieces in my presence, for the purpose of ascertaining the wear of the moving parts, the amount of which appeared so small as to be inappreciable. With respect to the second, viz:—the quantity of steam required to perform a certain amount of work—I have made several trials with an engine of this construction at the works of the British Alkali company, near Broomsgrove, which is applied to a great variety of work, but as a considerable portion of the duty performed consists of pumping, I was thus enabled to make such a comparison between the different portions of the work, as to obtain an accurate indication of the whole duty performed. The result of these trials is, that the work done by this twenty-four inch disc engine, working with steam at 29 lbs. pressure, is equal to twenty horses' power, after making ample allowance for friction; and the consumption of fuel (common Staffordshire coal) is equal to *two hundred weight*

per hour, or rather more than *eleven pounds* per horse per hour.—*Civ. Eng. and Arc. Jour.*

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For the American Railroad Journal, and Mechanics' Magazine.

METEOROLOGICAL RECORD FOR THE MONTHS OF JULY and AUGUST, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W.*)

| 1839 | Thermometer. | | | | | Remarks. |
|---|---|---|---|---|---|---|
| July. | Morn. | Noon. | Night. | Wind. | Weath. | |
| 1 | 74 | 84 | 80 | calm | clear | |
| 2 | 74 | 86 | 79 | NE | .. | |
| 3 | 76 | 88 | 82 | SE | .. | |
| 4 | 76 | 90 | 83 | calm | .. | evening cloudy |
| 5 | 77 | 91 | 83 | SE | .. | evening cloudy and distant thunder |
| 6 | 75 | 92 | 83 | calm | .. | |
| 7 | 78 | 80 | 81 | .. | cloudy | rain heavy thunder in the morning eve. clear |
| 8 | 76 | 83 | 83 | .. | clear | light showers in the morning clear day |
| 9 | 77 | 88 | 83 | .. | .. | |
| 10 | 78 | 88 | 82 | SW | .. | evening cloudy light shower heavy thunder |
| 11 | 78 | 79 | 79 | .. | .. | morning and forenoon distant heavy thunder |
| 12 | 76 | 80 | 78 | .. | cloudy | all day rain at night [no rain cloudy all day |
| 13 | 76 | 82 | 79 | .. | .. | " light showers |
| 14 | 78 | 76 | 74 | NW | .. | very heavy rain forenoon even. clear and calm |
| 15 | 72 | 81 | 74 | calm | clear | |
| 16 | 70 | 84 | 78 | .. | .. | |
| 17 | 71 | 83 | 78 | .. | .. | |
| 18 | 74 | 79 | 72 | NW | cloudy | rain all day |
| 19 | 72 | 80 | 76 | .. | .. | no rain |
| 20 | 72 | 82 | 72 | S | clear | morning rain in the evening |
| 21 | 71 | 88 | 78 | W | .. | all day |
| 22 | 77 | 87 | 82 | calm | cloudy | morning clear day |
| 23 | 75 | 87 | 83 | .. | clear | |
| 24 | 76 | 88 | 84 | .. | .. | |
| 25 | 76 | 90 | 86 | .. | .. | |
| 26 | 77 | 91 | 80 | SW | .. | evening cloudy |
| 27 | 75 | 90 | 80 | .. | .. | " " heavy distant thunder |
| 28 | 77 | 91 | 84 | W | .. | |
| 29 | 78 | 89 | 85 | calm | .. | |
| 30 | 80 | 91 | 85 | .. | .. | |
| 31 | 80 | 91 | 87 | NE | .. | |
| | 70 | 86 | 78 | ............ | ............ | mean temp. of the month 78.1. |
| Aug. | | | | | | |
| 1 | 78 | 91 | 80 | S | clear | |
| 2 | 76 | 90 | 80 | calm | .. | evening cloudy |
| 3 | 75 | 89 | 80 | SW | .. | shower afternoon |
| 4 | 78 | 89 | 78 | .. | .. | thunder shower in the evening |
| 5 | 76 | 89 | 86 | calm | .. | |
| 6 | 80 | 90 | 88 | SW | .. | |
| 7 | 81 | 92 | 85 | calm | .. | showers at night from north west |
| 8 | 81 | 88 | 83 | W | .. | |
| 9 | 80 | 88 | 81 | NW | .. | cloudy evening |
| 10 | 75 | 90 | 82 | calm | .. | |
| 11 | 76 | 89 | 81 | .. | cloudy | |
| 12 | 72 | 86 | 84 | .. | .. | |
| 13 | 72 | 87 | 80 | .. | .. | cloudy all day |
| 14 | 78 | 84 | 80 | .. | clear | |
| 15 | 74 | 86 | 80 | .. | .. | |
| 16 | 74 | 85 | 81 | W | .. | |
| 17 | 72 | 84 | 79 | calm | .. | evening cloudy, showers from north east |
| 18 | 73 | 83 | 80 | .. | .. | light showers at night |
| 19 | 75 | 80 | 74 | .. | .. | |
| 20 | 76 | 90 | 80 | .. | .. | |
| 21 | 70 | 90 | 80 | .. | .. | |
| 22 | 74 | 90 | 85 | .. | .. | |
| 23 | 74 | 91 | 80 | .. | .. | |
| 24 | 78 | 89 | 80 | .. | .. | |
| 25 | 79 | 83 | 70 | W | .. | showers afternoon |
| 26 | 78 | 84 | 79 | .. | .. | |
| 27 | 74 | 88 | 83 | S | .. | |
| 28 | 75 | 85 | 80 | W | .. | showers at daybreak |
| 29 | 70 | 84 | 78 | NW | .. | |
| 30 | 69 | 85 | 76 | .. | .. | |
| 31 | 66 | 85 | 75 | N | .. | |
| | 75 | 87 | 80 | ............ | ............ | mean temp. of the month 81. |

AMERICAN
# RAILROAD JOURNAL,
AND
# MECHANICS' MAGAZINE.

| | | |
|---|---|---|
| No. 11. Vol. III. New Series. | DECEMBER 1, 1839. | Whole No. 347. Vol. IX. |


The following suggestions of a friend have been too long delayed.

For the American Railroad Journal and Mechanics' Magazine.

In some of my operations it has occurred to me that columns made up of wrought iron round rods, could be usefully applied in several instances with good effect, say in store fronts, piazzas, verandahs, &c.; the idea will present itself most forcibly by comparing such columns with the "*open connecting rods*" of the steam engine. Light houses constructed on this principle, would afford very little resistance to either wind or wave, and would facilitate their erection in situations very much exposed, even upon breakers.

I have observed that cleaning the glass of the surveying compass on a cold day with a silk handkerchief, charges the glass with electricity, and in one instance, caused one end of the needle to rise into contact with the glass; may not the different states of excitement in the glass be the cause of the variation made by several instruments?—known as instrumental variation, not the "magnetic."

In Simms' treatise, some importance is attached to the method proposed of reading off and noting the indications of the level at the instrument and not at the staff as formerly. It appears to me that such an operation would be greatly facilitated by constructing the level so that it could be raised without derangement of the bubble, to coincide with the sub-divisions on the staff,—with a vertical motion of an inch at the instrument, the sub-divisions of the staff need not be less than $\frac{1}{2}$ inches, and they would thus be more readily recognized at a considerable distance.

GEORGIA.

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WISCONSIN RAILROAD.

We cheerfully give place to the following letter and memorial, and shall be pleased if in so doing we contribute to the success of the work in contemplation.

For the American Railroad Journal and Mechanics' Magazine.

SINIPEE, Grant County, Wisconsin,
October 18th, 1839.

Gentlemen—I have the honor to enclose a copy of a Railroad Memorial, to which I respectfully solicit your attention.

I am Gentlemen, very respectfully,

JOHN PLUMBE, JR.,
Chairman Wisconsin R. R. Committee Correspondence.

TO THE HONORABLE THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES IN CONGRESS ASSEMBLED.

The undersigned, citizens of respectfully represent:

That they deem the importance of a Railroad connexion between Lake Michigan and the Mississippi river, passing entirely across the Territory of Wisconsin, to be of such vast NATIONAL magnitude, as to entitle the project to the continuance of the most favorable regard of your Honorable Bodies, in appropriating the necessary means for its immediate completion.

Already has individual enterprise extended an almost entire chain of Railroads from the eastern limits of the Union to the shore of Lake Michigan; which will furnish a direct line of the most rapid and never interrupted communication from Maine to Iowa, with the single exception of about one hundred and fifty miles within the boundaries of Wisconsin; whose surface is so admirably adapted to the formation of Railroads as to require the least conceivable expenditure of labor in their construction.

If the benefits to be derived from the completion of this work were such as to accrue to Wisconsin and Iowa exclusively, it is confidently believed that the liberality of Congress would still afford to a considerable extent, at all events, the necessary aid to carry it into effect, if only in justice to these Teritories, in consideration of the large amount they have contributed to the receipts of the Treasury, in payment for lands and the tax upon lead.

But, when the NATIONAL importance of the improvement is taken into view, it would seem as if the enlightened wisdom of your patriotic Bodies could not possibly consent to retard the prosperity of our beloved country, by withholding the comparatively trifling appropriation which would secure to the Union, *generally*, advantages such as human capacity cannot estimate, but whose constantly increasing magnitude must continue to endure while America retains her name.

This Road would afford to the United States a most efficient and economical check upon the vast hordes of savage Indians, congregating to so formidable an extent upon her exposed and widely spread northwestern frontier, and would prove of paramount utility in the not impossible event of foreign invasion: and these considerations alone, aside from all others, would, we concive, be sufficient, in themselves, to insure to our memorial compliance with its prayer.

It would furnish the most desirable means of transporting her mails for an almost boundless extent of the fairest portion of our happy land, now rapidly filling up with enterprising and intelligent citizens; as well as of conveying her troops, military stores, and munitions of war, for the various permanent garrisons now existing, and to be farther increased, in the Indian country.

It would constitute a permanent link in the great Oregon Railroad, which the indomitable spirit of American enterprise will, at no distant day, exhibit to an admiring world, connecting our Atlantic with our Pacific sea-board.

But, independently of all National and prospective considerations, which so forcibly prove the importance of constructing the Wisconsin Railroad without any delay, the commercial business, alone, of the Upper Mississippi country would, beyond all question, afford a sufficient amount of transportation to render it a source of immediate profit, as soon as completed. Your memorialists will, therefore, conclude by respectfully expressing their firm conviction, that further argument would be superfluous in securing the object of their present solicitude.

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## ECONOMY OF FUEL.

(Continued from page 304.)

It would seem, therefore, that there can no longer be any excuse for a continuance of the wasteful practice of consuming the small coal at the pit's mouth, to say nothing of that which is thrown aside as useless in the pits themselves, and which never sees the light, since by this invention, that which was before considered as mere refuse, has acquired a certain fixed value, and it is to be hoped that this disgraceful practice is now completely put a stop to.

Of the various substances which have been used as a substitute for coal, where that article is scarce, peat stands foremost in the list. Our peat or turf beds are of great extent, especially in Ireland, and contain a valuable reserve of fuel, applicable, when properly prepared, to all the purposes of mining or manufactures. An important feature in this fuel is, that, unlike coal, of which we know of no instance of reproduction, turf or peat is continually being reproduced; in fact, in many parts of England the growth exceeds the consumption, and consequently the turf beds in those places are on the increase.

Before being used, however, this fuel requires to be thoroughly dried by exposure to the sun and air, during which process it contracts considerably in its dimensions, and increases in density, so much so as frequently to aproach in hardness and appearance to common coal. This, however, is only the case with bog peat, or that which is saturated with water, but turf may be made so by placing it at first in running water, and then suffering it to dry. Artificial means have been used for compressing peat;—and a machine for this purpose, invented by a patriotic nobleman, Lord Willoughby de Eresby, has been attended with complete success. The chief advantage of this invention is the great saving of time effected in the conversion of the wet peat into a solid dry fuel.

In France peat is extensively employed, both for domestic purposes, and in the different metallurgic processes, after having been converted into a charcoal by placing the peat to be carbonized in a furnace, where it is ignited, and smothered up in the usual manner. The iron made with this peat charcoal is described to be of a superior quality to Swedish iron, being more malleable, and more easily welder, owing, sa it is supposed, to its comparative freedom from sulphur, which is known to exist in large quantities in coal, and which is not completely driven off by its convertion into coke.

Very lately this peat coke has been introduced into some of the trans-atlantic steam boats, in combination with a certain proportion of resin. This resin fuel is not used alone, but when about 2½ cwt. of it are mixed with 20 cwt. of coal, a much better combustion of the coal takes place; and the effect is described as being equal to that which would be produced by 27 cwt. of coal. The mode of using it is by throwing it in front of the fire with each charge of fresh coal.

For many years the attention of scientific and practical men has been

directed to a method of using a valuable description of coal, the use of which, owing to its peculiar properties, has been until lately confined within a very narrow compass.

This fuel is the "anthracite," or stone coal of South Wales. Its chief properties consist in its freedom from sulphur or bitumen (being composed wholly of carbon, mixed with a slight proportion of oxide of iron, silex, and alumina,) its great durability and steady heat, burning clearly without smoke or flame. These valuable qualities have long secured to anthracite a very extensive use in the drying of malt in many districts of England, where it is preferred even to coke or charcoal; but it is only within the last few years that it has acquired the high rank of importance, in a national as well as a domestic point of view, which it now possesses.

Dr. Arnott, for whose stoves it is exclusively recommended by him, has declared that it is a blot in the police regulations of London, that all great manufacturers are not confined to the exclusive use of this description of coal, its non-emission of smoke and noxious vapors, tending so much to preserve the purity of the atmosphere in the metropolis. Since, so long back as the reign of Elizabeth, the burning of coal was prohibited in London during the sitting of parliament, lest the health of the knights of the shire should suffer duing their abode in London (so careful was this queen of the health of her subjects;) it is surely incumbent on us in the present day, when from the immense increase of the number of manufactories of every description, the atmosphere of London is never clear from smoke, to pass some legislative enactments to remedy the growing evil. Experiments have satisfactorily proved that anthracite gives out in combustion 30 per cent. more caloric than coke or bituminous coal.

In America, this valuable mineral has been long and extensively employed, not only for manufacturing processes, but also in steam navigation, and for locomotive engines; also for the warming of apartments, and for every other domestic purpose; indeed its cheapness, the intensity and durability of the heat which it produces, together with its perfect safety and freedom from smoke or smell, give it a decided preference over every other species of fuel.

Mines of this coal have for some years been extensively worked in Rhode Island, Massachusetts and other States; but it is in Pensylvania that it is found in the greatest abundance; there the anthracite coal formation covers a tract of country many miles in length and breadth, extending across the two entire counties of Luzerne and Schuylkill. Throughout this region it is obtained with very little labor, being situated in hills from 300 to 600 feet high above the level of the surrounding rivers and canals, and consequently easy of transportation to all parts of the Union. It exists in horizontal beds, from 15 to 40 feet in thickness and covered merely by a few feet of gravelly loam. This coal has been found in several European countries, and exists abundantly in Ireland; but the great supply of anthracite for this country is found in that part of the great coal formation which environs Swansea and Carmarthen bays, and which forms a part of the great coal field of South Wales. Here it exists in immense quantities.

It is, however, but very recently that the attention of engineers has been turned to the use of this fuel for locomotive engines; a short time since, a trial of it was made under the sanction of the directors of the Liverpool and Manchester railway, and the following is the report of the talented engineer of that company:—

In the first instance, the engine ran out with a load about six miles, and the coal was found to do very good duty without any difficulty being expe-

rienced, either with the tubes, or in the getting up of the fires. The engine brought back a load of coal wagons, from the Hetton Colliery, and acquired a speed of 21 miles an hour, thus loaded. Another trial was made in the evening with the same engine for the whole distance to Manchester, taking five loaded wagons; the journey was performed in one hour and twenty-nine minutes. The consumption of anthracite was only 5½ cwt. although a large portion was wasted from the fire bars being too wide apart for the economical use of this fuel. The engine would have used upwards of 7½ cwt. of coke for the same journey, with the same load."

The trial with locomotives then, must be considered quite conclusive, and the next object most deserving the attention of practical men, is the application of anthracite to the marine engines of sea going steam vessels. When it is considered that 30 per cent. at least is saved in the stowage by this description of fuel, the importance of this subject will be at once made manifest, and there can be little doubt that with certain trifling alterations, in the construction of the boiler and furnace, the object may be attained.

It is not surprising that, considering the importance which has of late years been attached to every means of economising fuel, the attention of scientific and practical men should have been directed to various methods for accomplishing this object, and numerous alterations and improvements have been effected in the furnaces and boilers of steam engines, by which the heat given forth by combustion has been made more available, but much remains yet to be done, as a very large quantity of heat is lost, from the smoke which is wasted, the heat which passes up the chimney, and from the imperfect manner in which coal is generally consumed.

An ingenious invention for intercepting and returning to the boiler fire, a large portion of the heat which would otherwise pass up the chimney and be dissipated, was brought into notice in England a few years ago, by a German named Schauffelen, and was denominated "Schauffelen's Hot-air Furnace Feeder." The invention consists in the use of a number of metal pipes or tubes open at the bottom, but closed at the top. These pipes are placed in a vertical position in the chimney, and the air in passing through them becomes heated from the current of hot air passing up the chimney, and in this state is supplied to the fire, all ingress of cold air being carefully excluded by means of closely fitting iron plates attached to the ash pit.

With respect to the amount of saving in fuel effected by this apparatus, it is stated by the inventor as varying from 20 to 25 per cent., when in good working order, and its advantages are not entirely confined to a saving of part of the heat which would otherwise escape up the chimney, but moreover, a more intense heat in the fire place is maintained, and consequently a more complete combustion of the fuel and smoke takes place.

Another invention of great simplicity for the economy of fuel, and the prevention of smoke, is described in the *Mining Review* of August 31, 1838. The process consists merely in the introduction into the furnace of steam in small quantities, through a tube taken from the boiler, and discharged over the fuel at any convenient place. The end of the tube should be formed with a fan-shaped termination, perforated with minute apertures so as to throw the steam in small jets down upon and over the fire. One effect produced is *the absolute prevention of smoke*; another, the operation of the fire is fully doubled, and the steam employed, itself consumed. The employment of steam also greatly increases the draft of the chimney.

"It is held by competent authorities, that one pound of Newcastle coal (supposing the whole of the heat emitted by its combustion was made available,) should drive off in steam 14 lbs. *of water*. This however, is

very far beyond what is actually done in practice, by ordinary steam engine boilers. Indeed it is found by experience to require as much as one pound of coal to convert into steam four to six pounds of water, six pounds being considered a high product. By means of Mr. Ivison's method however, it is found that an average of thirteen pounds of water are evaporated by one pound of ordinary Scotch coal, thus more than doubling the results heretofore obtained, and consequently effecting a saving of upwards of 50 *per cent.* of fuel.—*Mining Review*, August 31, 1838.

One great source of loss of heat and consequently of fuel, in most large establishments where steam power is extensively employed, arises from the radiation of heat which is constantly taking place from the boiler, where, as is most frequently the case, no means are adopted for preventing it. When we consider the large surface that is exposed by each steam engine boiler, and that from this there is continually going on a powerful radiation of heat into the surrounding atmosphere, it is evident that the loss from this source alone, must be immense. If, therefore, this large body of heat can by any means be intercepted and returned to the boiler, it is clear that there will be a saving of all that fuel which was required to raise that heat in order to disperse it again. The method of doing this is simple, and attended with very little expense. All that is necessary to be done is to surround the boiler with a jacket or casing of wood or brick, leaving a space of a few inches between it and the boiler, to be filled with some substance which is a slow conductor of heat. The material that has been employed for this purpose, is a mixture of sawdust and ashes, rammed in so as to lay close to every part of the boiler; and where this system is carried to its full extent. which is in the large pumping engines, used in the mines in Cornwall, not only the boiler, but also the cylinder and steam pipes, are in the Cornish engines, completely encased with some non-conducting material, which renders the engine and boiler houses as cool as the interior of a dwelling house, where there are only ordinary fires—a sure proof that little or no heat is lost by radiation.

Another proof of the efficacy of this system is, that even after the engine has been standing still for 12 hours very little heat is lost, and if it is necessary to start it suddenly, as in case of emergency, scarcely any time is lost in raising the steam, and *one fourth* the fuel only is required; whereas, in the common engines and boilers, where every vessel containing steam is exposed to the atmosphere, it takes from 20 minutes to half an hour, firing hard, to raise the steam to the requisite pressure.

It would occupy too much time, and swell these remarks to too inconvenient a length, were I to enter into the details of all the inventions that have been proposed for economising fuel, although many of them are of great value, as their general adoption sufficiently testifies; whilst others either from the complexity of their parts, or their general inapplicability, have soon fallen into disuse. It is hoped, however, that sufficient has been said in this paper, to point out the great importance of the subject, and to show, that however much may have been hitherto done, much yet remains to be done, before we can confidently state that the whole *inherent virtue* residing in one pound weight of coal or other fuel, is made available.

FREDERICK S. PEPPERCORNE.

*April* 8, 1839.

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*A New Enterprize.*—The Philadelphia Inquirer states that Mr. Jacob Ridgway has in contemplation, early next spring, to run a line of steamboats, stages and locomotives, between Philadelphia and New York, via. Trenton and New Brunswick, at the price of two dollars for the whole

route. The stage department is to be under the superintendence of Mr. Reeside.

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ON CERTAIN FORMS OF LOCOMOTIVE ENGINES.—BY EDWARD WOODS.

Among the causes which contributed to the success of the earlier experiments in locomotion upon the Liverpool and Manchester Railway, the method of generating steam deserves the most prominent place. The chamber or fire-place, containing a large mass of fuel surrounded on every side by water, with its appendage of tubes, or small flues disposed in the interior of the boiler, and exposing a large surface to contact of the heated air, was well calculated to turn to good account whatever heat the fuel during its combustion might produce.

It is however by no means improbable that this ingenious contrivance would have failed in securing the end proposed, and would perhaps even have been abandoned, but for the judicious application of a discovery, then only recently made, the practicability of producing a strong artificial draught of air through the fire, with facility and economy, by the exhausting power of a jet of waste steam directed upwards into the chimney.

The powers of the arrangement as thus combined, were attested by a very rapid generation of steam, and by the consequent attainment of a speed of travelling nearly threefold greater than any previous system had accomplished.

It is therefore less a matter for surprise that few attempts should have been made to improve upon so simple and effective a form of boiler, while material variations were taking place in the outward plan and disposition of the machinery.

Under the hands of different builders of locomotive engines for railways, the boilers have been subject to various slight modifications; but, whether fire boxes have been constructed of iron or of copper, whether square with stays, or round without stays, whether the tubes have been more or less in number, of larger or smaller size, or of different material, the combination of both, as it existed in the earliest engines, has been adopted on every line of railway where the transport of passengers is a primary object.

The case has been otherwise with the machinery destined to render available the resources which the boiler so abundantly provides; and builders, actuated by caprice and the desire of differing from competitors, or more laudably influenced by the indications of experience, or by some happy effort of their own ingenuity, have departed widely from the first models submitted for their imitation.

Many crude schemes have successively appeared before the public, and have been deservedly rejected; many useful applications have withstood the test of time, and remained embodied in the machines to whose utility they have subserved. But although practical and scientific men are as equally agreed in condemning some inventions, as they are in approving others, there exists a class of forms, respecting the individuals of which, a great and reasonable difference of opinion is still entertained.

It is proposed in the present paper to state, with regard to a few of such forms, some results which the working of the Liverpool and Manchester line has afforded, and to consider what general arrangements of the parts of the locomotive engine are most conducive to its efficiency and durability, under the requirements of a railway intended for the transport of heavy loads at high speeds. The leading features into which a discussion upon the subject may with propriety resolve itself, bear reference to the relative superiority of—

Engines with four and with six wheels;
Engines with inside and with outside framings;
Engines with crank axles and with outside crank pins;
Engines coupled and uncoupled; and the forms arising out of different combinations of these with each other.

*Engines with four or with six wheels and inside or outside framings.*

The engines at first introduced upon the Liverpool and Manchester line of railway were found to be much too slightly constructed for sustaining the shocks and strains to which their high velocities, and the inequalities of the road, continually exposed them; so that after a service, short in its duration, but actually and unexpectedly great in respect of the distances travelled, each individual engine required and underwent a thorough and general repair. The nature of such repair consisted principally, at least as far as mechanical causes contributed to deteriorate the machine, in the substitution of greater strength and more approved forms of material, with a disposition and mode of connection of the parts, better adapted to resist frequently repeated and periodical concussions.

Thus the outer and inner framings were stayed in various directions; wooden wheels were replaced with iron ones; crank axles were constructed with almost double the original quantity of material; pistons, piston-rods, connecting rods and brasses were proportionally strengthened, until, finally, little remained of the old engine but its boiler and cylinders.

Such extensive alterations naturally occasioned a considerable addition to the weight, and it was found accordingly, that the engines first operated upon, built after the form of the "Rocket," and originally weighing from four and a half to five tons, became at least two tons and a half heavier than before; while others subsequently introduced, and known under the denomination of the "Planet" class, were increased in nearly the same proportion arriving ultimately at no less than ten tons.

However conducive to the durability of the engine these alterations might prove, the effect of greater weight moving upon the road, could not be otherwise than highly prejudicial. The road was in fact formed of rails intended to support a moving mass of not exceeding four tons and a half distributed upon four wheels.

Indeed the terms prescribed in the competition for the premium publicly offered in 1329, shortly before the opening of the railway, required of the builder or inventor who proposed to submit his engine for trial, that it should be supported upon not less than *six* wheels, if the weight exceeded *four and a half*, or fell short of *six* tons; six tons, inclusive of the complement of coke and water, being the extreme limit allowable.

It was soon found impracticable to maintain the road in a state of efficient repair, when subjected to the influence of such disproportionate weights, rolling at great speeds, and frequently acting with the full force of impact due to the velocity of descending deflected portions of the rails. The rails were seriously bent, continually becoming loose in their supports, and frequently broken.

To return to the lighter form of engine, had it been even practicable, would not have been desirable; the only alternative that remained, and of which the adoption was ultimately decided upon, being to relay the whole line with stronger rails, and in the mean time to apply precautionary measures to lessen the evils adverted to. Such measures were rendered indispensably necessary by the arrival of some engines of still greater weight than any before in operation.

The most obvious remedies were: first, to place temporary props under

the rails between the points of support, and more especially near the ends of the rails; and secondly, to add a third pair of wheels to the hind part of the framing of the engine. Both these expedients were extensively resorted to. The "Mars" and the "Atlas" first underwent the alteration, followed by the "Titian," "Orion," "Hercules," "Thunderer," "Firefly," "Planet," and others, engines originally provided with only four wheels.

In the structure of engines which have cylinders within the framing, and consequently inside cranks, it is a necessary condition that the centre of the main or crank axle should be placed in a position to allow the crank and connecting rod ends to clear the front of the fire-box during their revolution. This circumstance evidently limits the distance from the crank axle to the centre of gravity, and causes considerably more than half the weight to rest upon this axle, inasmuch as the fire-box, with double casing, fuel, bars, &c., constituting by far the heaviest proportion of the engine within a given length, completely overhangs its centre.

From hence has resulted, during the rapid transit of engines upon an uneven surface, (and no railway has yet been constructed free from inequalities,) a continual vibratory motion in a plane perpendicular to the direction of the axles.

Now as the effect of any downward motion in the vertical plane, or in other words, the amount of injury sustained reciprocally by the engine and the road, is expressed by the velocity which the centre of gravity has acquired in vertical descent, multiplied by the weight of the body, so most injury is received when the wheels of the large axle pass the obstacle, because for any given amount of their depression or elevation, the centre of gravity falls or rises through a greater space. The more equally we can divide the centre of gravity between the bearing lines, and the larger the interval between those lines, the greater becomes the steadiness of the machine. Considerations of this nature are necessarily influenced by the general form and dimensions of the parts to be acted upon.

The established form of the locomotive engine did not so much admit of alteration as of addition, and accordingly the third pair of wheels was placed behind the fire-box, to aid in its support.

The advantages obtained were almost immediately apparent. The engine lost in a great degree its peculiar rocking motion, as also the unsteadiness arising from lateral undulations; which later effect was in like manner attributable to the diminution of the angle of which the oscillations were susceptible. Beside such direct and immediate results, time soon developed further consequences of an important nature. The component parts of the engine remained for a much longer period than before securely united and firm, the fastenings of the tubes became less liable to leak and give way, and the bolts and stays of the framings were less disturbed. Lastly, though not of least importance, an inherent source of safety was superadded, in the diminished liability of the engine to run off the rails in the event of the large wheels or the crank axle breaking. Instances in which this quality has been put to the proof have occasionally occurred. They have invariably demonstrated the high importance of the application as an especial security to passengers and to the attendants; and in consequence the principle introduced was not abandoned, even after the road had been entirely relaid with new rails.

### INSIDE AND OUTSIDE FRAMING.

Intimately connected with the safety of railway travelling, and with the mode in which the application of six wheels can be turned to best account, is the often agitated question of an outside framing. It cannot admit of doubt in the mind of any one at all conversant with the properties of machinery, that an axle or shaft

impelled by any given power will revolve more steadily, in proportion as the distance is greater between the bearings, provided at the same time, its form be of strength sufficient to resist deflection. No bearings can be made, or if made, could long continue in strict mathematical adjustment with the axis of motion. Where the power is uniform and acting only from one direction, as in the case of a wheel and axle driven by a strap, or by another wheel, a slight deviation from truth is of comparatively small importance, and in fact occasions no perceptible amount of eccentricity in the motion; but when the impelling power is variable in its action, and not only variable but applied alternately to opposite sides of the axis, the wear of bearings proceeds in a two-fold direction, and the want of accuracy becomes detrimental to the machine. Were the power (supposed acting periodically on both sides of the axle) constant in its nature, in so far as that at the same moment it only impelled the same side, the axle would simply roll to and fro in its bearings during such periods, accompanied indeed by a slight shock at the moment of reversal, but preserving throughout its parallelism. The case with the locomotive engine is in this respect different. The axle with its double crank is urged by two independent forces, not operating simultaneously but periodically, opposed to each other; and the consequence ensues, that the axle, the wheels, and finally the engine itself, is thrown into a state of vibration, the angle of which is precisely in the inverse ratio of the distances between the bearings. Hence those engines whose bearings are only about four feet asunder, soon acquire play in the brasses, and unless frequently examined and repaired, become unsteady and even unsafe when travelling at rapid speeds.

This consideration (one as I conceive of great importance) does not immediately involve the principle of an outside framing, inasmuch as greater length of axle may be obtained by widening the road, but it has an indirect reference, when the contiguity of bearings is found objectionable, and the width of the way does not admit of alteration. The superior danger of the inside above the outside framed engine, consists in the fact, that should the wheel of the former become loose, or the axle break, the engine would almost inevitably fall over on its side; whereas in the other form of engine placed under similar circumstances, the wheel remains confined within the framing, tending to support the whole, until the attendants shall have been able to arrest the further progress of the train. The application of the outside framing is attended with another advantage, of which the beneficial effects are exhibited in imparting, when properly constructed, a degree of elasticity to the whole machine, tending to equalize and reduce the injurious effect of concussions received during motion upon an uneven plane.

### OBJECTIONS TO SIX WHEELS.

The principal objections that have been urged against six wheels are:

1st. That they have less adhesion than four-wheeled engines.

2d. That the axle and the weight of wheels adds to the resistance, and consequently detracts from the available power.

3d. That they cannot traverse curves without increased strain and friction.

I shall offer some observations, seriatim, upon these objections.

With regard to the first, it is perfectly true that the adhesion is less; for adhesion is proportional to pressure or weight, and the same weight supported on four wheels must exert a greater pressure per wheel than when it rests upon six; but the real question to be considered is, whether the *ratio* between the adhesion and the power of the engine is not such as to permit the exertion of that full power in ordinary states of the railway and

under the practical conditions of the traffic. Observations on the working of the Liverpool and Manchester line since the introduction of six wheels, have convinced me of the present sufficiency of adhesion. On referring to the weekly returns of the "late arrivals of coach trains," with their causes, during the year 1837, the following particulars have been extracted of all delays alleged to have arisen from the slipping of the engine wheels. The account stands thus:

| | | |
|---|---|---|
| In 3640 | coach trains (first and second class) despatched from Liverpool to Manchester, the delays by slipping have amounted altogether to . . . . . . . . . | 412 |
| In 3640 | coach trains despatched from Manchester to Liverpool, the delays by slipping have amounted altogether to . | 792 |
| 7280 | Trains delayed. | 1204 |

Averaging one-sixth of a minute for each train on its trip of thirty miles.

The greatest delays recorded are about 30 minutes, the least 3 minutes;* the trains consisting of six or seven carriages. The time of performing the trip is one hour and a half for a first class, and two hours for a second class train. As the trips are frequently performed in less time, it is but fair to conclude that the actual loss of time by slipping is considerably greater than what is here assigned. I should imagine the real amount to be at least double.

The cases in which trains suffer delay by slipping, form, therefore, rather the exception than the rule, the existing inconvenience might, however, be almost entirely removed by coupling the wheels.

The Liverpool and Manchester engines have undergone little alteration in the ratio of adhesion to power, the power having in most instances remained the same, the weight only being increased, and the surplus weight sustained on an extra support. Engines altogether new are seldom of less weight in proportion to their power than those of the older make, as the "Mars" and the "Atlas."† The usual weight is about eleven tons and a half, and nearly thus divided:

| | tons. | cwt. | qrs. |
|---|---|---|---|
| On the fore wheels . . . . . . | 4 | 10 | 0 |
| ——— driving wheels . . . . . | 5 | 0 | 0 |
| ——— hind wheels . . . . . . | 2 | 0 | 0 |
| Total . . | 11 | 10 | 0 |

Some engines are found frequently more subject to slip than others, although the weights upon the driving wheels have been the same, and the

* It may excite surprise that the delays experienced in the trips from Manchester to Liverpool should exceed those of the trips in the contrary direction. The fact is accounted for by two circumstances, which in any state of the road tend to render the times unequal. The station at Liverpool, from whence the locomotives start, is higher than the terminus at Manchester by 43½ feet. The trips from Liverpool are therefore performed on an average descent of 43½ feet in 30 miles, and those from Manchester on an average ascent of 43½ feet in the same distance. The latter will be thus found to require about 14 per cent. more power than the former for an equal load, or, in other words, the load of the engine is increased, and consequently the tendency to slip. The second circumstance alluded to is the prevalence of westerly winds during a great part of the year. These, by increasing the resistance to be overcome, occasion considerable detention in the aggregate of a year's work.

| | tons. | cwt. | qrs. | | tons. | cwt. | qr. | | tons. | cwt. | qrs. | Increase. tons. | cwt. | qrs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| † Mars, originally | 4 | 15 | 0 | + | 2 | 14 | 1 | = | 7 | 9 | 1 | 2 | 4 | 1 |
| now | . | . | . | | . | . | . | = | 9 | 13 | 2 | | | |
| Atlas, originally, | . | . | . | | . | . | . | = | 8 | 11 | 2 | 3 | 3 | 3 |
| now | . | . | . | | . | . | . | = | 11 | 15 | 1 | | | |

construction in other respects identical. This is, without doubt, to be attributed to malformation of the springs, and want of due adjustment to the weights they have to support. Our engine builders are remiss in their attention to the subject, and the springs of most new engines have to be taken in pieces and remodelled before they can become thoroughly serviceable. Rapidity of recoil when the wheel passes an obstacle is the point to be aimed at.

To the second objection I do not attach much importance; the additional weight of a pair of wheels, axle, springs, and pedestals, does not exceed 12 cwt., and therefore on a liberal estimate cannot oppose greater resistance than ten or twelve pounds, equal to about $\frac{1}{200}$th of the whole tractive power of the engine, a quantity insignificant when put in competition with any real advantage gained. Some portion of the power of the four-wheeled engine must be expended in the oscillatory motion, as well as in overcoming the friction of flanges continually rubbing against the rail; and such portion would, I conceive, be found even to overbalance the extra resistance of a third pair of wheels.

The third objection, viz., the tendency to strain and the friction in passing round curves, and the difficulty of "taking the points," is prevented by the simple expedient of rendering the pedestals to the axle of the hind wheels very light and elastic, so that they will yield readily sidewise to an impression. For this purpose it is found better to use small wheels, say three feet in diameter, that the plates of the pedestals may be long, and the axles at a considerable distance below the framing. These plates are in some instances carried up on one side only of the frame; the opposite plate is turned underneath, and the whole acquires more flexibility. Such precautions render uncoupled six-wheeled engines capable of traversing safely curves of eight chains radius, at a speed of from 6 to 8 miles an hour; an instance has occured of a short curve of only four chains radius being passed at a slow speed. The common plan of allowing play in the axle journals to meet the difficulty of passing curves, appears to be rather prejudicial than otherwise.

The application of the principle of elasticity should not stop at the hind wheels, but be in fact extended, though in a less degree, to the entire framing. In every railway, *lateral* as well as vertical inequalities exist, which continually drive the engine out of the straight line. The framing, if made pliant and yielding to lateral impulse, will be found to bend slightly, without disturbing the whole mass. The provision is, in fact, tantamount to a secondary and subordinate system of springs, and the engine as well as the road are less deranged, while at the same time an increase of available power is obtained, and the speeds are consequently faster.

Engines possessing only inside framings are evidently unsusceptible of lateral elasticity. Such framings are required, not merely to serve as carriages for the *boiler*, but likewise to sustain many parts of the machinery, a condition absolutely requiring inflexibility. Outside framings act simply as carriages to the boiler, and have no fixed connection with any other part. The machinery in these is attached exclusively to the *boiler*, and is less exposed in that position to casual jolts and strains.

(To be continued.)

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## THE KILSBY TUNNEL.

The Kilsby Tunnel is about 2,423 yards long, and was intended at first to be formed eighteen inches thick in the brick work; but it was found ne-

cessary to increase this, in most cases to twenty-seven inches. The whole has been built in either Roman or metallic cement.

The works were commenced in June, 1835, by the contractors; but such serious difficulties were met with, at an early stage of the proceedings, that they gave up the contract in March, 1836, and nearly the whole work has been performed by the company. Previous to the commencement of the works, trial shafts were sunk in several parts of the line of the tunnel, in order that the nature of the ground through which it would have to pass might be ascertained; and it was found to be generally lias shale, with a few beds of rock—in some places dry, in others containing a considerable quantity of water.*

In sinking the second working shaft, it was found that a bed of sand and gravel, containing a great quantity of water, lay over part of the tunnel; and this was such a perfect quicksand, that is was impossible to sink through it in the ordinary way. By repeated borings, in various directions near this part of the tunnel, the sand was discovered to be very extensive, and to be in shape like a flat bottomed basin, cropping out on one side of the hill. The trial shafts had accidently been sunk on each side of this basin, so that it had entirely escaped notice until the sinking of the working shaft.

Mr. Stevenson was led to suppose that the water might be pumped out, and that under the water thus drained the tunnel might be formed with comparative facility; this proved to be the case. Engines for pumping were erected, and shafts sunk a little distance out of the line of the tunnel. The pumping was continued nearly nine months before the sand was sufficiently dry to admit of tunnelling, and during a considerable portion of that time the water pumped out was 2,000 gallons per minute. The quicksand extended over about 450 yards of the length of the tunnel, and its bottom dipped to about six feet below the arch.

In May, 1836, one of the large ventilating shafts was commenced, and completed in about twelve months. This shaft is sixty feet in diameter, and 132 feet deep; the walls are perpendicular and three feet thick throughout, the bricks being laid in Roman cement. The second ventilating shaft is not so deep by thirty feet. These immense shafts were all built from the top downwards, by excavating for small portions of the wall at a time, from six to twelve feet in length and ten feet deep.

In November, 1836 a large quantity of water burst suddenly into the tunnel, in a part where there were no pumps; it rose very rapidly, and in order to prevent the ground being loosened by it at the far end, where it was excavated, a rather novel mode of building the brick work was resorted to. This was by forming a large raft, and on this the men and their materials were floated into the tunnel, and with considerable difficulty and danger performed their task.

All the difficulties were at last conquered, and the tunnel finished in October, 1838; but of course the expenses were increased to a very great extent. The directors felt it to be their duty not to restrict the proper outlay of capital, when satisfied it would secure the convenience of the public, the stability of the works, and the efficient management of the traffic; and they felt persuaded that a perseverance in this course, to the completion of the undertaking, would be found most economical in the end, and best calculated to secure the permanency of that successful result which is now hap-

* Organic remains at Kilsby are very numerous. In some parts of the excavation there is hardly a cubic inch without shells and other remains presenting themselves to the eye, and as the earth taken out has been principally laid into spoil, there will be ample opportunities, for some time yet, for further examination, which would well repay either the scientific inquirer or the cabinet collector.

pily placed beyond the reach of doubt. The contract for making the Kilsby Tunnel was 99,000*l.*, and it has cost more than 300,000*l.*, or upwards of 230*l.* per yard.

To give some idea of the magnitude of this work :—There were thirty millions of bricks used in it, which at ten hours for a working day, if a man counted fifty in a minute, would take one thousand days to get through them all. There were above a million of bricks employed in the deepest ventilating shaft, and its weight is 4,034 tons. The weight of the whole tunnel is 118,620 tons; or it would freight four hundred ordinary merchant ships, of about three hundred tons each; and if these bricks were laid end to end they would reach 4,260 miles. The quantity of soil taken from the tunnel was 177,452 cubic yards.

The great ventilating shafts are perfect masterpieces of brickwork, and are found fully to answer the purpose for which they were intended, leaving the tunnel entirely free from any offensive vapor immediately after the transit of each train, and their magnitude can only be estimated by standing in the tunnel and looking upwards.

The passage through this mighty work of engineering skill and ingenuity leaves on the mind, even of those unacquainted with the ordinary difficulties of such an undertaking, a vivid impression of the rare talents of those who designed the work, and superintended its execution. These talents, however, will be more especially appreciated by those who are aware of the many and unforeseen obstacles which arose during its progress.—To Mr. Charles Lean, the assistant engineer under whose direction it was completed, great credit is due for his skill and unremitting exertions, and for the great care he bestowed upon the men in the arduous and dangerous duties in which they were constantly engaged. * * * *

The history of the great railway between London and Birmingham is now finished. A wonderful work it is to look upon, whether it be contemplated in its magnitude and difficulties, its science and capital, or its utility and results. It stands as much the monument of this age as any of the great works of antiquity that have been the subjects of the world's history. There is however, this difference in its favor, that while they have been raised in the cruel exercise of despotic power, and have mainly subserved the purpose of personal vanity, this has been accomplished by the profitable employment of the redundant capital of a single district, to meet the wants of a vastly improved people, and is the triumphant invention of science, trained and disciplined under severe study and gathering accelerated strength from the successful experiments of each succeeding year. The flexible power of steam was indeed known to the philosophers of former times; but they used this knowledge only for the fantastic purposes of caprice and amusement. Anthemius, in the age of Justinian, employed his acquaintance with this principal to annoy a troublesome neighbor, and by imitating an earthquake frightened Zeno out of his house; and at an after period, Pope Sylvester invented an organ, which was set in motion and worked by it. It is the glory of the present era, that science and utility go hand in hand to advance the improvement and happiness of the nation.

Every age of the world has furnished its own peculiar inventions, and these have generally been well adapted to the wants that suggested them, and to the condition in which society was at that time placed. It is a subject more than commonly interesting to contemplate genius toiling amidst so many difficulties, and by patient perseverance overcoming all perplexity and opposition. It is perhaps still more interesting to observe it under the trials of its first experiments, amidst the doubts, unbelief and sometimes

jeers, of the multitude, self possessed in the truth of its principle, yet tremulously fearful while lying at the mercy of the thousand contingencies that might thwart or destroy its hopes and expectations. Such was the case with Telford, on the final erection of the famous hanging bridge over the Menai Straits. It is said that his heart sunk as every successive bolt was struck, till overcome with the agony of his feelings, he retired to his cottage hard by and awaited on his knees the result. The shouts of the admiring populace, when the wonderful fabric settled into its place across the turbulent waters, and his own almost inarticulate thanksgiving in his secret chamber, arose together in the triumph of that hour.

When poor Henry Bell, after years of thought, labor and experiment, first pushed his steam vessel on the Clyde, it was done amidst the scoffs and evil surmises of those who assembled to witness the scene. The inventor died in poverty; but an obelisk that rears itself on the banks of that fine river, near Dunglass, attests the tardy, and to him almost useless, gratitude of his countrymen. Fulton embarked on the Hudson with the same contemptuous greetings and prognostications, from the very people who assembled in thousands to hail the arrival of the Great Western and Sirius steamers across the vast Atlantic, to their own shores. He lived to see, and in some degree to share, the complete scccess of his genius and mechanical skill.* How deeply we are indebted to these children of science who carried forward their discoveries—in the benefits of which we so largely participate—almost broken hearted, amidst the chilling indifference or the withering contempt of a selfish world!

The work of which we have been treating has involved nearly, if not altogether, a capital of six millions of money in its completion. This enormous amount will require three hundred thousand pounds per annum, merely to pay its interest, at five per cent., besides a very considerable sum in addition, to defray the wear and tear, and other expenses of its yearly operations; and yet with all this immense outlay, it is certain, from the host of travellers it will allure into a state of locomotion from pleasure or profit and the various lines that will eventually flow into it, that it will be one of the most productive railways in the kingdom. We cannot, indeed, clearly foresee the end of such an invention, of which this is one of the greatest experiments, or the condition of society it may ultimately produce; but we are warranted in believing that this onward state of improvement, by facilitating and enlarging the sphere of social communication, will tend greatly to increase the amount of social happiness; and in its combining and assimilating influences over the great human family, will assist in bringing about the benevolent purposes of Him, "who hath made of one blood all nations of men for to dwell on all the face of the earth."

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## THE IRON TRADE.

"ON THE STATE AND PROSPECTS OF THE IRON TRADE IN SCOTLAND AND SOUTH WALES, IN MAY, 1839," WAS READ BEFORE THE LIVERPOOL POLYTECHNIC SOCIETY, ON THE 13TH OF JUNE, BY JOSEPH JOHNSON, ESQ., IRON MERCHANT, LIVERPOOL.

The vast and increasing importance of the iron trade to this country must be so apparant to the most indifferent observer, that I feel fully persuaded I need offer no apology to you for intruding upon your notice the consideration of a subject that appears, at first sight, so completely without the legitimate sphere of the objects for the promotion of which this society was

* The engine used by Fulton, in his first steam boat on the Hudson river, was made by Messrs. Boulton and Watt, of Soho.

established. The daily increasing magnitude of this branch of British industry is surprisingly great; but to enable you to obtain a clear view of its rapid extension, I have extracted from Dr. Ure's valuable "Dictionary of Arts, Manufactures and Mines," the following sketch of its progression from 1740 to 1826. The Doctor observes, p. 687, that, "Till 1740, the smelting of iron ore in England was executed entirely with wood charcoal, and ores employed were principally brown and red hematites. Earthy iron ores were also smelted; but it does not appear that the clay ironstones of the coal basins were then used, though they constitute almost the sole smelting material of the present day. At that era there were 59 blast furnaces, whose annual product was 17,350 tons of cast-iron—that is for each furnace, 294 tons per annum, and $5\frac{1}{8}$ tons per week. By the year 1788 several attempts had been made to reduce iron ore with coked coal; and there remained only twenty-four charcoal blast furnaces, which produced altogether 13,000 tons of cast-iron in the year, being at the rate of 546 tons for each per annum, or nearly 11 tons per week. This remarkable increase of 11 tons for $5\frac{1}{8}$ was due chiefly to the substitution of cylinder blowing machines, worked with pistons, for the common wooden bellows.

"Already 53 blast furnaces, fired with coke, were in activity, which furnished *in toto* 48,800 tons of iron in a year, and which raises the annual product of each furnace to 907 tons, and the weekly product to about $17\frac{1}{2}$ tons. The quantity of cast iron produced that year (1788) by means of coal was 48,800 tons, and that by wood charcoal was 13,100, constituting a total quantity of 61,900.

"In 1796, the wood charcoal process was almost entirely given up, when the returns of the iron-trade, made by desire of Mr. Pitt, for establishing taxes on the manufacture, afforded the following results:—121 blast-furnaces, furnishing in the whole per annum 124,879 tons, giving an average amount of each furnace of 1,032 tons.

"In 1802, Great Britain possessed 168 blast-furnaces, yielding a product of about 170,000 tons, and this product amounted, in 1806, to 250,000 tons, derived from 227 coke furnaces, of which only 159 were in activity at once,

"In 1820, the make of iron had risen to 400,000 tons, and in 1826 to about 600,000 tons.

"From 1823 to 1839 the iron-trade saw many fluctuations. The price of forge pig-iron varying from 2*l.* 10*s.* to 10*l.* per ton at the works. But the make of this country was still increasing, and, in 1838, I believe it reached upwards of 1,000,000 tons."

For many interesting particulars connected with the iron trade of the United Kingdom, and particularly for a detailed account of the introduction of the heated air-blast, by Mr. Neilson, of Glasgow, I must refer you to the excellent work from which I have made the foregoing extracts.

The introduction of the hot-blast formed quite a new era in the iron trade, and the consequent increase of produce of iron, particularly in Scotland, where this invention was first applied, has been incredibly great, and is still progressing. I have been very kindly furnished by a friend, who is intimately connected with the Scotch iron trade, with a list of all the furnaces now in operation in Scotland, the number out of blast, the number erecting, and about to be erected; I have every confidence in the accuracy of my friend's information, and have no doubt but that the correctness of the list may be relied upon. This list shows that there are in Scotland fifty furnaces in blast, five out, seven building, and twenty-six contemplated. With the permission of the meeting, I will read over the names of the works, and their respective owners.

| Names of Works. | Owners. | In Blast. | Out of Blast. | Building. | Contemplated. |
|---|---|---|---|---|---|
| Clyde | James Dunlop | 4 | 1 | — | 4 |
| Calder | W. Dixon and Co. | 6 | — | — | — |
| Carron | Carron Company | 4 | 1 | — | — |
| Muirkirk | Muirkirk Iron Co. | 2 | — | — | — |
| Devon | Devon Iron Co. | 2 | 1 | — | — |
| Shotts | Shott's Iron Co. | 2 | — | 1 | — |
| Monkland | Monkland Iron Co. | 5 | — | — | — |
| Gartsherrie | W. Baird and Co. | 7 | — | 1 | 6 |
| Dundyvan | Dunlop and Co. | 5 | — | 1 | 4 |
| Summerlee | Wilsons and Co. | 4 | — | — | 2 |
| Castle-hill | Shott's Iron Co. | 2 | — | — | — |
| Bona | Bona Iron Co. | 1 | — | — | — |
| Govan | W. Dixon, Esq. | 2 | — | — | 4 |
| Wilsontown | W. Dixon, Esq. | 1 | — | — | — |
| Coltness | Mr. Holdsworth | 2 | — | — | — |
| Omoa | W. Young | 1 | — | — | — |
| Carnbroe | Allson and Co. | — | — | 2 | 4 |
| Galston | M'Callam and Co. | — | 1 | — | — |
| Blair | Mr. J. M'Donald | — | — | 2 | — |
| Housle | Mr. Galloway | — | 1 | — | 2 |
| | | 50 | 5 | 7 | 26 |

Supposing the whole of these furnaces to be in full activity by the end of the year 1842, and giving the average produce of eighty tons per week to each furnace, we shall have Scotland alone producing upwards of 360,000 tons of cast-iron per year, nearly equaling the make of the United Kingdom 20 years ago. Sixty-five out of eighty-seven furnaces I have enumerated, are situated in or about the Monklands, to the south and south-east of Glasgow, and distant from that city seven to ten miles. The works in that district have the command of the blackband ironstone, the possession of which my informant states to be so great an advantage, that without it, the trade would not be worth following. The furnaces in the Monklands, by using this combustible blackband ironstone, may average 100 tons in seven days each but those which have not this material, do not yield nearly so large a quantity. Therefore, bearing in mind that the Presbyterians stop their furnaces one shift, or nearly twelve hours on each Sunday, we may safely put down the average yield of the furnaces in Scotland at 80 tons per week each.

Three of the largest makers of iron in Scotland are directing their attention to the manufacture of bar-iron, and with every prospect of most complete success. The Monkland Iron Company are erecting mills and forges capable of making 230 tons malleable iron per week. Dunlop, Wilson and Co., of Dundyvon, are making preparations to enable them, when in full operation, to make 300 tons of bars, &c., weekly, and they will be partially at work in two months. William Dixon, Esq., of Govan Iron Works, has now ready for immediate working, capabilities for producing 200 tons of malleable iron per week. His mills and forges are on the outskirts of Glasgow, and are known as the Glasgow Iron Works, at the Town Head.

The Muirkirk Iron Company have five puddling furnaces, rolling mill, &c., but they are not making more than about 20 tons of bars weekly.

This statement comprises the present, and so far as is known, the prospective operations in the malleable iron trade in Scotland, with the exception of two small forges, the Lancefield and the Gartness, where they puddle a little from white iron.

It was for a long time considered doubtful whether the Scotch cast-iron, made as it is with raw bituminous coal and heated air, would answer for malleable iron, and several experiments have lately been made with a view to ascertain more nearly than had hitherto been done its applicability for this purpose. So far as I have been able to learn, these experiments have been attended with most satisfactory results. I was informed a few days ago by Edmund Buckley, Esq., of Manchester, who has for a long time past taken a very lively interest in these matters, that in some trials recently made by Messrs. Beecroft, Butler and Co., at their works, at Kirkstall, near Leeds, they found 4 cwt. 2 qrs. of Scotch pig-iron to yield, by the process of boiling instead of puddling, blooms of 4 cwt. 1 qr. 8 lbs. each, showing only the comparatively trifling waste of 20 lbs. in a charge of 4 cwt. 2 qrs., and the quality of the iron was found to be at least equal to any made with cold air. Indeed, many thousand tons of Scotch cast-iron have been purchased from time to time by the iron masters of South Wales to mix with their own country metal in their puddling furnaces, thus affording unquestionable proof of its fitness for conversion into malleable iron. I have no doubt that we may speedily receive extensive supplies of bar-iron from Scotland, such as we have hitherto received principally from South Wales and Staffordshire.

I must now ask your indulgent attention for a little while longer, and request the favor of your company on a very interesting tour through the mineral districts of the counties of Gloucester, Monmouth, and Glamorgan. I class the iron works of the Forest of Dean with those of South Wales, as well from their proximity to the latter, as from the circumstances of their being worked by those eminent South Wales iron masters, Messrs Guest, Lewis and Co., and W. Crawshay and Sons. At the "Cinderford" works there are four furnaces, three in blast, and one out, producing on an average from 100 to 120 tons each of excellent forge pig iron weekly. At the "Sewdley" works there are two furnaces, one in and one out of blast, producing about ninety tons of iron per week; and at the Park-end works there are two furnaces, one in blast and the other out, making about eighty tons per week.

The differences in the produce of furnaces may be accounted for in a variety of ways: some are larger than others, some have superior blowing engines and others may be under better management. The furnaces I have named are all that are on the Forest of Dean; but large quantities of iron ore are raised here, and are sent, as well as the iron, to different works in South Wales and Staffordshire. The shipments are made at a wharf a little below Newnham.

Leaving the forest we will proceed to Newport. Here you will find a most excellent river navigation—the Usk; and at all seasons of the year may be seen large numbers of vessels, of various tonnage, waiting to receive the mineral produce of Monmouthshire, in the shapes of coal and iron. Having viewed the port, and noted all its facilities for shipment, and especially the magnificient dock now constructing for affording to the shipping increased conveniences, we will, if you please, proceed to the interior of the county and notice the various works in the order in which we reach them.

The first works we arrive at are those of Capel Hanbury Leigh Esq., near Pontypool, and are called the Pontypool Iron Works. Here you will find three furnaces in blast, and one out; two blown with cold air, and one with hot. There are not any furnaces erecting, or about to be erected here. The make of these three furnaces is about 300 tons per week. The hot air pigs are sold chiefly for foundry purposes, and the cold air iron is used

by Mr. Leigh for tin plates, of which he has been for a long time past a very eminent maker. The yield of the iron stone at these works is about 30 per cent.; but Mr. Leigh imports large quantities of the richer ores from Lancashire and Cornwall, for the improvement of the quality of his iron.

A little further up the valley we reach the works of the Pentwyn and Golynos Iron Company, where you will find five furnaces all in blast, and one about to be erected; three are blown with hot air, and two with cold. The produce of the five furnaces is about 450 tons per week. They have just completed first rate forges and rolling mills, calculated to make 350 tons of bar and other malleable iron per week. About a mile above these works, you find those of the British Iron Company, at Abersychan. Here are four furnaces in blast, all blown with cold air, and two out of blast.—The four make about 380 tons of pig iron per week, from which they make about 270 tons of malleable iron, and the remainder is made into castings, etc.

We next arrive at the Varteg Iron Company's works, where you will find five furnaces all in blast, four blown with hot and one with cold air.—They produce about 350 tons of pig iron per week, from which they make about 160 tons of bars and rails, about twenty tons of castings for engine uses, &c., and the remainder is sold for foundry purposes.

Pursuing our course for two miles further up this valley, we arive at the works of the Blaenavon Iron Company, where we find five furnaces all in blast, blown with cold air and six others erecting. This mineral property, I am told is one of the best and most valuable in the county of Monmouth, and these works have been long distinguished for the superior strength and general excellence of their iron. These five furnaces produce about 400 tons of cast iron per week, about one-half of which is refined, and part of it made into cable iron, and the remainder is sold for tin plates and foundry work. This company are erecting extensive forges and rolling mills, and will, in a few years, contribute largely to the supply of bar iron and rails.

We have now arrived at the extremity of the first valley, and crossing the mountain, we will descend to Abergavenny. The rolling mills on the left hand side are those of the Garndyrris Iron Company, and have been worked for many years by the late firm of Messrs. Hills and Wheely.—They are now united to the Blaenavon Iron Works, and are carried on by the same company.

By the time we have reached Abergavenny, I strongly suspect that you will feel disposed to enjoy the comforts of a good dinner, an evening walk in that most delightful country, and a refreshing sleep, for all of which gratifications you will here find the most ample provision.

Next morning, after the usual and very necessary preliminaries, we resume our tour, and in about five miles we reach the works of the Clydach Iron Company, at Llanelly. Here are four furnaces at work, and all blown with cold air. They produce about 320 tons of pig iron per week, from which they make about 230 tons of bars, &c., and the remainder is run into castings and ballast iron.

The Nant-y-glo Works, are the next we arrive at, situated as their name imports in the Valley of Coal. Here, some years ago, was expended upwards of 50,000*l.* in attempts to establish a profitable iron work, but without success; and not until the property was purchased by the present talented and enterprising proprietors, Messrs. Joseph and Crawshay Bailey, was any remuneration realised. These works now rank amongst the very first class. Messrs. Baily have, within the last few years, purchased the Beaufort Iron works. At the two establishments they have fourteen fur-

naces in blast, ten blown with cold and four with hot air, and I am informed that they intend erecting four others very soon. Their make of pig iron is from 1200 to 1300 tons per week, from which they make about 750 tons bars, rails and rods, and the remainder is sold for foundry purposes.

Near the Nant-y-glo works, and situated in the same valley, are the Coalbrook Vail Company's works, consisting of three furnaces all blown with cold air, and another is about to be erected. The make of the three furnaces is 160 to 180 tons of cast iron per week, all of which they make into castings, or dispose of for that purpose.

A mile lower down this valley you reach the Blaina and Cwm Celyn Iron Company's iron works. These two properties have recently been purchased by a joint stock company, and promise well for their proprietors.—Messrs. Russell and Browns, the former proprietors, are the managing directors. At Blaina they have two furnaces in blast, and one about to be erected, all blown with cold air. They yield about 120 tons of pig iron per week, which is nearly all made into castings on the spot. At Cwm Celyn they are building four furnaces, the entire produce of which is to be made into malleable iron.

We have now finished our inspection of the works in the second valley, and will proceed to the third, which is called Ebbw Vale, from the river Ebbw flowing through it.

(To be continued.)

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Railroad Reports.—The following communication, in relation to the publication of railroad reports by Engineers, of *uniform size and style*, as proposed by the publishers of this Journal, is given with a view of calling attention to the subject, and of soliciting the co-operation of the profession in carrying it into practice. It is to be regretted that the plan had not been adopted at an earlier day. It is not, however, as our correspondent says "too late" even now, to adopt it—certainly not as difficult as it would be to adopt a *uniform width of track*, a measure which was urged by us when there was not *half-a-dozen* railroads in use in the United States; with little effect however, as will be seen on examining the numerous reports to be found in the Journal.

For the American Railroad Journal and Mechanics' Magazine.]

Gentlemen:—I perceive by an advertisement on the cover of the last number of your Journal, that you have it in contemplation to publish *extra copies* of railroad reports, which you may be employed to print for railroad Companies and Engineers, as well as of those which you may publish from time to time in the Railroad Journal, of uniform size, that they may be bound up in a volume corresponding with the Journal. I am pleased with the plan, as it will enable Engineers and others, to possess many Reports, in a convenient form for reference; and I regret exceedingly, that you had not, long ago, adopted the measure, as in that case, you would now have been in possession of documents, in a separate form, of great value to the profession. It is not, however, too late now to adopt it; and I hope you will be employed by all Engineers and Companies that can *send* and *receive* their Reports without too much trouble; as I am confident that by so doing, they will aid in the collection and preservation of much important information, in the most convenient form for use, and at the same time give

a lifting hand to the Journal, without incurring additional expense to themselves. You would, I think, do well to place the subject fairly before your readers, and urge upon them with some earnestness, the propriety of aiding you in carrying out your proposition.

Yours, truly, D.

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Harlem Railroad.—The receipts on this road for the month of November are as follows:

| | | |
|---|---|---|
| Nov. 1st to 30th, inclusive, | 1839, | 7083 98 |
| Nov. 1st to 30th, | 1838, | 4436 18 |

showing an increase in the last month over the corresponding month of last year of $2647 80, equal to 59 3-4 per cent. increase.

The number of passengers taken on the road between the city hall and 15th street, who paid sixpence only, were, for the last five months, 247,732 persons.

The receipts on this road for the last quarter, ending the 30th Nov. are as follows:

| | | | | |
|---|---|---|---|---|
| In September, | 1838 | $8,770 80 | in 1839 | $12,881 48 |
| " October | " | 7,846 85 | " | 11,501 87 |
| " November | " | 4,436 18 | " | 7,083 98 |
| | | $21,053 83 | | $31,467 33 |

showing an increase over the corresponding quarter of last year of $10,403 50, equal to 494 per cent. and at the rate of 41,614 00 per annum.

The total receipts for fare for the year ending on the 1st of May, 1839 were $79,794 74, while the receipts of the last seven months are $77,673-34, being within $2,122 40 of as much as was received on the whole of last year, from May 1st 1838 to the 1st of May 1839.

This company are now conveying more than one million two hundred thousand passengers per annum on a railroad constructed by them and kept in order at their expense, from which it is obvious that a great saving accrues to the City treasury, inasmuch as the same number of passengers conveyed in carriages, would subject the City to an increased expenditure to keep in repair the pavements over which they would travel.

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## THEORY OF THE STEAM-ENGINE.

### CHAPTER III.—OF THE LAWS WHICH REGULATE THE MECHANICAL ACTION OF THE STEAM.

(Continued from page 319.)

*Section III.—Relation between the relative volumes, the pressures and the temperatures, in the steam in contact or not in contact with the liquid.*

As it has just been observed, neither Boyle's law nor that of Gay-Lussac can apply alone to changes which take place in the steam remaining in contact with the liquid. But it is clear that from the two, a third relation may be deduced, whereby to determine the variations of volume which take place in the steam, by virtue of a simultaneous change in the temperature and in the pressure; and this relation may then comprehend the case of the steam in contact with the liquid, since it will suffice to introduce into the formulæ the pressures and temperatures which, in this state of the steam, correspond to each other.

Suppose then it be required to know the volume occupied by a given weight of steam, which passes from the pressure $p'$ and temperature $t'$, to

the pressure $p$ and temperature $t$. It may be supposed that the steam passes first from the pressure $p'$ to the pressure $p$ without changing its temperature, which, from Boyle's law, will give between the relative volumes of the steam, the analogy

$$\mu''=\mu' \frac{p'}{p};$$

then supposing this steam to pass from the temperature $t'$ to the temperature $t$, without changing its pressure, the relative volume of the steam, from the law of Gay-Lussac, will become

$$\mu=\mu'' \frac{1+\cdot 00202\ (t-32)}{1+\cdot 00202\ (t'-32)}=$$

$$=\mu' \frac{p'}{p} \cdot \frac{1+\cdot 00202\ (t-32)}{1+\cdot 00202\ (t'-32)}.$$

This formula will then express the law according to which the relative volume of the steam changes, by virtue of a given combination of pressure and temperature. Consequently, substituting in this equation for $p$ and $t$, $p'$ and $t'$, the pressures and temperatures only which correspond to each other in the steam in contact with the liquid, we shall have the analogous changes which take place in the relative volume of the steam, when it is not separated from the water which generated it.

On the other hand, it is known by experience, that under the atmospheric pressure, or 14·706 lbs. per square inch, and at the temperature of 212° of Fahrenheit's thermometer, the relative volume of the steam in contact with the liquid is 1700 times that of the water which has produced it. Hence it is easy to conclude the relative volume of the steam at any given pressure $p$ and at the corresponding temperature $t$. It suffices, in fact, to insert the above values for $p'$, $t'$, and $\mu'$, in the general equation obtained above, and the result will be

$$\mu=1700 \times \frac{14\cdot 706}{p} \times \frac{1+\cdot 00202\ (t-32)}{1+\cdot 00202 \times 180}=$$

$$=18329\, \frac{1+\cdot 00202\ (t-32)}{p}.$$

Thus we may, by means of this formula, calculate the relative volume of the steam generated under a given pressure, as soon as we know the temperature answering to that pressure in steam at the maximum of density for its temperature.

It is what we have done in the construction of the following table. The second column has been formed by calculating the temperature of the steam at the maximum density, from the formulæ which we have given in the first section of this chapter. Then using this series of temperatures in the formula which precedes, we have concluded the third column, or the relative volumes of the steam in contact with the liquid, under all the pressures comprised between 1 and 8 atmospheres. This table will, in consequence, dispense from all calculation with regard either to the research of the temperatures, or to that of the relative volumes of the steam; and its extent will suffice for all applications that occur in the working of steam engines.

When we speak of steam *generated* under a given pressure, we understand the steam considered at the moment of its generation, and consequently still in contact with the liquid. We have explained elsewhere that the volume of the steam, compared to that of the water which has produced it, is precisely what we call the *relative* volume of the steam.

*Table of the volume of the steam generated under different pressures, compared to the volume of the water that has produced it.*

| Total pressure, in English pounds, per sq. inch. | Corresponding temperature by Fahrenheit's thermometer. | Vol. of steam compared to the vol. of water that has produced it. | Total pressure, in English pounds, per sq. inch. | Corresponding temperature by Fahrenheit's thermometer. | Vol. of steam compared to the vol. of water that has produced it. |
|---|---|---|---|---|---|
| 1 | 102·9 | 20954 | 56 | 289·6 | 498 |
| 2 | 126·1 | 10907 | 57 | 290·7 | 490 |
| 3 | 141·0 | 7455 | 58 | 291·9 | 482 |
| 4 | 152·3 | 5695 | 59 | 293·0 | 474 |
| 5 | 161·4 | 4624 | 60 | 294·1 | 467 |
| 6 | 169·2 | 3901 | 61 | 294·9 | 460 |
| 7 | 176·0 | 3380 | 62 | 295·9 | 453 |
| 8 | 182·0 | 2985 | 63 | 297·0 | 447 |
| 9 | 187·4 | 2676 | 64 | 298·1 | 440 |
| 10 | 192·4 | 2427 | 65 | 299·1 | 434 |
| 11 | 197·0 | 2222 | 66 | 300·1 | 428 |
| 12 | 201·3 | 2050 | 67 | 301·2 | 422 |
| 13 | 205·3 | 1903 | 68 | 302·2 | 417 |
| 14 | 209·0 | 1777 | 69 | 303·2 | 411 |
| 15 | 213·0 | 1669 | 70 | 304·2 | 406 |
| 16 | 216·4 | 1572 | 71 | 305·1 | 401 |
| 17 | 219·6 | 1487 | 72 | 306·1 | 396 |
| 18 | 222·6 | 1410 | 73 | 307·1 | 391 |
| 19 | 225·6 | 1342 | 74 | 308·0 | 386 |
| 20 | 228·3 | 1280 | 75 | 308·9 | 381 |
| 21 | 231·0 | 1224 | 76 | 309·9 | 377 |
| 22 | 233·6 | 1172 | 77 | 310·8 | 372 |
| 23 | 236·1 | 1125 | 78 | 311·7 | 368 |
| 24 | 238·4 | 1082 | 79 | 312·6 | 364 |
| 25 | 240·7 | 1042 | 80 | 313·5 | 359 |
| 26 | 243·0 | 1005 | 81 | 314·3 | 355 |
| 27 | 245·1 | 971 | 82 | 315·2 | 351 |
| 28 | 247·2 | 939 | 83 | 316·1 | 348 |
| 29 | 249·2 | 909 | 84 | 316·9 | 344 |
| 30 | 251·2 | 882 | 85 | 317·8 | 340 |
| 31 | 253·1 | 855 | 86 | 318·6 | 337 |
| 32 | 255·0 | 831 | 87 | 319·4 | 333 |
| 33 | 256·8 | 808 | 88 | 320·3 | 330 |
| 34 | 258·6 | 786 | 89 | 321·1 | 326 |
| 35 | 260·3 | 765 | 90 | 321·9 | 323 |
| 36 | 262·0 | 746 | 91 | 322·7 | 320 |
| 37 | 263·7 | 727 | 92 | 323·5 | 317 |
| 38 | 265·3 | 710 | 93 | 324·3 | 313 |
| 39 | 266·9 | 693 | 94 | 325·0 | 310 |
| 40 | 268·4 | 677 | 95 | 325·8 | 307 |
| 41 | 269·9 | 662 | 96 | 326·6 | 305 |
| 42 | 271·4 | 647 | 97 | 327·3 | 302 |
| 43 | 272·9 | 634 | 98 | 328·1 | 299 |
| 44 | 274·3 | 620 | 99 | 328·8 | 296 |
| 45 | 275·7 | 608 | 100 | 329·6 | 293 |
| 46 | 277·1 | 596 | 105 | 333·2 | 281 |
| 47 | 278·4 | 584 | 120 | 343·3 | 249 |
| 48 | 279·7 | 573 | 135 | 352·4 | 224 |
| 49 | 281·0 | 562 | 150 | 360·8 | 203 |
| 50 | 282·3 | 552 | 165 | 368·5 | 187 |
| 51 | 283·6 | 542 | 180 | 375·6 | 173 |
| 52 | 284·8 | 532 | 195 | 382·3 | 161 |
| 53 | 286·0 | 523 | 210 | 388·6 | 150 |
| 54 | 287·2 | 514 | 225 | 394·6 | 141 |
| 55 | 288·4 | 506 | 240 | 400·2 | 133 |

### *Section IV.—Direct relation between the relative volumes and the pressures, in the steam in contact with the liquid.*

It has just been seen, from the formulæ given in the preceding section, that the density and the relative volume of the steam, whether separated from the liquid or not, are known in terms of the simultaneous pressure and temperature. It is likewise known that in the steam in contact with the liquid, the temperature depends immediately on the pressure. It should therefore be possible to find a relation proper to determine directly the relative volume of the steam in contact with the liquid, or, in other words, of the steam at the maximum density and pressure for its temperature, by means of the sole knowledge of the pressure under which it is formed.

The equation which gives the relative volume of the steam in any state whatever, in terms of its pressure and temperature, has been given above. We have also shown the formulæ which serve to find the temperature in terms of the pressure, in steam in contact with the liquid. Eliminating then the temperature from the equation of the volumes and that of the temperatures, we shall obtain definitely the relation sought, or the relative volume of the steam at the maximum density, in terms of the pressure only.

But here starts the difficulty. First, Mr. Biot's formula not being soluble with reference to the temperature, does not admit the necessary elimination. In the next place, the assemblage of the three formulæ reported above, which are made to succeed each other, suit very well in the formation of tables of correspondence between the pressures and the temperatures, when that is the end proposed. Likewise, in an inquiry relative to the expansion of the steam in an engine, when it is known precisely within what limis of pressure that expansion will take place, it may immediately be discerned which of the three formulæ is applicable to the case to be considered, and then $t$ may be eliminated between that formula and the equation of volumes. But if the question regards, for instance, the case wherein the steam generated in the boiler under a pressure of 8 or 10 atmospheres, might, according to the circumstances of the motion, expand during its action in the engine, either to a pressure less than 1 atmosphere, or to a pressure between 1 and 4 atmospheres, or in fine to a pressure superior to 4 atmospheres; then we shall not know which of the three formulæ to use in the elimination, and it will be impossible to arrive at a general equation representing the effect of the engine in all cases.

Besides, were we even to adopt any one of those equations, the radicals they contain would render the calculation so complicated as to make it unfit for practical applications.

The equations of temperature hitherto known cannot then solve the question that presents itself, that is to say, satisfy the wants of the calculation of steam-engines in this respect; and, consequently, the only means left is to seek, in a direct manner, an approximate relation, proper to give immediately the relative volume of the steam at the maximum density in terms of the pressure alone.

With this view Mr. Navier had proposed the expression:

$$\mu = \frac{1000}{\cdot 09 + \cdot 0000484\, p},$$

in which $\mu$ is the *relative* volume, or the ratio of the volume of the steam to that occupied by the same weight of water, and $p$ the pressure expressed in kilograms per square metre. But this formula, though exact enough in high pressures, deviates considerably from experience in pressures below that of the atmosphere, which, however, come under consideration in condensing engines. Moreover, for non-condensing engines, it is possible to

find one much more exact, as it will presently be seen. We deem it then proper to propose, on this subject, the following formulæ :

Formula for *condensing engines* of various systems;

$$\mu=\frac{10000}{\cdot 4227+\cdot 00258\, p.}$$

Formula for *non-condensing engines ;*

$$\mu=\frac{10000}{1\cdot 421+\cdot 0023\, p.}$$

In these formulæ, the pressure $p$ is expressed in pounds per square foot.

The former of the two suits equally to pressures superior or inferior to that of the atmosphere, at least within the limits that it may occur to consider in applying them to steam-engines.

We know that the greatest pressure used in the boiler never surpasses 8 atmospheres, or 120 lbs. per square inch; and on the other hand, that it can, in no case, be required to calculate the effects of steam acting as a moving force in an engine, at a pressure inferior to 8 or 10 lbs. per square inch, or about $\frac{2}{3}$ of an atmosphere. In a condensing engine, for instance, the steam, after the communication with the condenser has been opened, never descends into the cylinder at a pressure less than 4 lbs. per square inch; the friction of the engine, besides, may be estimated at 1 lb. per square inch; and it is impossible to suppose a load which shall not, of itself and with the additional friction it occasions in the engine, produce a resistance against the piston of at least 3 lbs. per square inch. Thus the resistance to be overcome by force of the steam, cannot in any case be less than 8 lbs. per square inch; consequently the steam cannot descend into the cylinder at a pressure less than 8 lbs. per square inch. A formula which gives the exact volumes down to that pressure, is then all that can be necessary for the calculations that may occur, and we shall presently see that the proposed formula fulfils that condition.

The first of the formulæ might also, without any noticeable error, be applied to non-condensing engines. Since, however, in these the steam can hardly be spent at a total pressure less than two atmospheres, by reason of the atmospheric pressure, the friction of the engine and the resistance of the load, it is needless to require of the formula exact volumes for pressures less than 2 atmospheres. In this case, then, the second formula will be found to have a greater degree of accuracy, and we shall in consequence prefer it.

It will be remarked that, besides necessity of these formulæ in the general calculation of the effect of steam-engines, they have the advantage moreover, for other purposes in the arts, of dispensing entirely with tables of temperature, and of supplying the place of tables of the volume of the steam, when these are not at hand.

Finally, to give a precise idea of the approximation given by the two formulæ just mentioned, we here subjoin a table of the values they furnish for the principal points of the scale of pressures.

*Relative Volume of the Steam generated under different pressures, calculated by the proposed formulæ.*

| Total pressure of the steam in pounds per square inch. | Volume of the steam, calculated by the ordinary formulæ. | Volume calculated by the proposed formula for condensing engines. | Volume calculated by the proposed formula for non-condensing engines. |
|---|---|---|---|
| 5 | 4624 | 4386 | " |
| 6 | 3901 | 3771 | " |
| 7 | 3380 | 3307 | " |
| 8 | 2985 | 2946 | " |
| 9 | 2676 | 2655 | " |
| 10 | 2427 | 2417 | " |
| 11 | 2222 | 2218 | " |
| 12 | 2050 | 2049 | " |
| 13 | 1903 | 1904 | " |
| 14 | 1777 | 1778 | " |
| 15 | 1669 | 1668 | " |
| 20 | 1280 | 1273 | 1243 |
| 25 | 1042 | 1030 | 1031 |
| 30 | 882 | 864 | 881 |
| 35 | 765 | 745 | 768 |
| 40 | 677 | 654 | 682 |
| 45 | 608 | 583 | 613 |
| 50 | 552 | 526 | 556 |
| 55 | 506 | 479 | 509 |
| 60 | 467 | 440 | 470 |
| 65 | 434 | 407 | 436 |
| 70 | 406 | 378 | 406 |
| 75 | 381 | 354 | 381 |
| 80 | 359 | 332 | 358 |
| 85 | 340 | 312 | 338 |
| 90 | 323 | 295 | 320 |
| 105 | 281 | 254 | 276 |
| 120 | 249 | 222 | 243 |
| 135 | 224 | 198 | 217 |
| 150 | 203 | 178 | 196 |

*Section V.—Of the constituent heat of the steam in contact with the liquid.*

There is yet an inquiry, relative to the properties of steam, which has long fixed the attention of natural philosophers: it is that of the quantity of heat, necessary to constitute the steam in the state of an elastic fluid under various degrees of elasticity.

It is well known that when water is evaporated under the atmospheric pressure, in vain new quantities of heat may be added by means of the furnace, neither the temperature of the water, nor that of the steam ever rise above 100° of the centigrade thermometer, or 212° of Fahrenheit. All the heat then which is incessantly added to the liquid must pass into the steam, but must subsist there in a certain state which is called *latent,* because the heat, though really transmitted by the fire, remains nevertheless without any effect upon the thermometer, nor does it afterwards become perceptible till the moment of disengaging itself, on the steam being condensed.

This latent heat evidently serves to maintain the molecules of water in the degree of separation suitable to their new state of elastic fluid; and it is then absorbed by the steam, in a manner similar to that which is absorbed by the water, on passing from the solid state, or state of ice, to the liquid.

But it is important to know the quantity of the latent heat, in order to appreciate with accuracy the modifications the steam may undergo.

Some essays made by Watt had already elicited, that the steam, at the moment of its generation, or in contact with the liquid, contains the same quantity of total heat, at whatever degree of tension, or, in other words, at whatever degree of density it may be formed. The experiments of Messrs. Sharpe and Clement have since confirmed this result. From them is deduced, that the quantity of latent heat contained in the steam in contact with the liquid, is less and less, in proportion as the temperature is higher; so that the total heat, or the sum of the latent heat plus the heat indicated by the thermometer, form in all cases a constant quantity represented by 650° of the centigrade thermometer, or, 1170° of Fahrenheit's.

Southern, on the contrary, has concluded from some experiments on the pressure and temperature of steam, that it is the latent heat which is constant; and that, to have the total quantity of heat actually contained in steam formed at a given temperature, that temperature must be augmented by a constant number, representing the latent heat absorbed by the steam in its change of state.

Some authors have deemed this opinion more rational, but the observations we are about to report seem to us to set the former beyond all doubt.

It is known, that when an elastic fluid dilates itself into a larger space, the dilatation is invariably attended with a diminution of temperature. If, then, the former of the two laws is exact, it follows that the steam, once formed at a certain pressure, may be separated from the liquid, and provided it lose no portion of its primitive caloric, by any external agent, it may dilate into greater and greater space, passing at the same time to lower and lower temperatures, without ceasing on that account, to remain at the maximum density for its actual temperature. In effect, since we suppose that the steam has in reality lost no portion of its total heat, the consequence is that it always contains precisely as much as suffices to constitute it in the state of maximum density, as well at the new temperature as at the former.

If, on the contrary, Southern's law be exact, when the steam, once separated from the liquid, will diminish in density as it dilates into a larger space, it will not remain at the maximum density for the new temperature. To admit indeed that it would do so, would be to verify Watt's law, since the new steam would be at the maximum density, although containing precisely the same quantity of total heat as the old. But since we admit, on the contrary, that the primitive steam contained more heat than was necessary to constitute the new at the maximum density, it follows that the surplus heat, now liberated, will diffuse itself into the new steam; and as this is separated from the liquid, the increase of heat cannot have the effect of increasing the density of the steam, but will be altogether sensible in the temperature. Thus the result will be, a steam at a certain density, indicated by the spaces into which it is dilated, and at a temperature higher than what is suitable to that density, in steams at the maximum of density for their temperature.

Now, in a numerous series of experiments of which we shall speak hereafter, we have found that in an engine whose steam-pipes were completely protected against all external refrigeration, the steam was generated at a very high pressure in the boiler; and, after having terminated its action in the engine, escaped into the atmosphere at pressures very low and very varied; and that in every case, the steam issued forth precisely in the state of steam at the maximum of density for its temperature. Southern's law then is inadmissible, unless any one choose to suppose that in these varied changes of pressure, the steam lose, by contact with the very same external

surfaces, always precisely and strictly just that quantity of heat, sometimes very considerable, at other times very small, by which its temperature should have increased. Consequently we regard the law of Watt as the only one supported by the facts.

The total quantity of heat contained in the steam in contact with the liquid, and under any pressure whatever, is then a constant quantity; and according as the sensible heat increases, the latent heat diminishes in an equal quantity.

On the other hand, according to the same law, if we conceive water to be enclosed in a vessel capable of sufficient resistance, and submitted to temperatures of greater and greater intensity; the latent heat of the steam thence arising, will be less and less as the sensible heat or temperature shall become greater; and as soon as the steam shall be generated at a temperature equal to 650° centigrade or 1170 degrees of Fahrenheit, it will cease to absorb heat in a latent state, and will no longer receive any portion of it, but which will be sensible on the thermometer. We must then conclude that at this point the steam will have a density equal to that of water; since in passing from one state to another, it requires no farther increase of caloric, as would be necessary if any farther increase of severance were to take place between the molecules. Thus the water, though still contained in the vessel, will all have passed into the state of steam. From this moment then, new quantities of heat may be applied to the vessel; but instead of acting on a liquid, it will now act only on an elastic fluid, and therefore all the increase of heat which is added, will, as in all gases, become sensible on the thermometer.

This observation explains the difficulty, which would otherwise present itself: viz., that beyond 650 degrees centigrade or 1170 of Fahrenheit, the preceding law could not subsist without the latent heat becoming a negative quantity, which had been the cause of this law being rejected by some authors.

(To be continued.)

## IMPORTANT INVENTION IN THE MANUFACTURE OF PAPER HANGINGS

We were favored a few days since with an opportunity of visiting the extensive paper works of Messrs. J. Evens and Co., at the Alder Mills, near Tamworth, where we had the pleasure of witnessing the application of an ingenious and very beautiful piece of mechanism, the invention of the Messrs. Evens, to the printing of paper hanging, which cannot fail to produce a complete change in this department of our manufactures, from its superiority over the ordinary method of block printing. The Messrs. Evens would have brought their invention into practical operation many years ago, had it not been for the heavy duties imposed on the manufacture of stained papers, which by limiting the consumption, rendered their invention comparatively useless, a fact which supplies another argument against the imposition of heavy duties upon the manufacturing skill and industry of the country. In connection with the present invention, we may here state that the Messrs. Evens took out a patent in February last, for an important improvement in the manufacture of paper, by the application of a pneumatic pump in the compression of the moisture from the pulp, by which means the substance is almost instantaneously converted into paper. By this invention they are, we understand, enabled to manufacture a continuous sheet of paper six feet in width, and nearly 2,000 yards in length every hour. This paper, as it is taken off the reel, is in every respect fit for immediate use, and is conveyed on rollers to another part of the mill, in which the printing machinery is erected, through which it is passed with great rapid-

ity, and receives the impression of the pattern intended to be produced, with all the precision and beauty of finish which machinery can alone effect. In order to connect the operations of the paper making and printing machines the Messrs. Evens are at present engaged enlarging their premises, and when this alteration is completed they will be enabled to print, glaze, and emboss, the most complicated and delicate pattern in paper hangings, in every variety of shade or color, as rapidly as the paper can be manufactured. Some idea may be formed of the power of the machinery, and the importance of the invention, when we state that during our visit to the mill, the machinery was working at a rate which would produce 1,680 yards of paper per hour, consisting of two very beautiful patterns, the only hand labor employed being that of one man, who superintended the machinery, and four girls, employed in rolling up the paper in pieces of the required length. The whole process of manufacturing the paper from the pulp and impressing it with the most complicated pattern, is carried on within a comparatively small space, and with a precision and rapidity which affords another instance of the progress and triumph of science and mechanical skill, in supplying the necessaries and comforts of civilized life. We understand it is the intention of Messrs. Evens to exhibit some specimens of their beautiful manufacture at the forthcoming meeting of the British Assocation, and we feel confident that amongst the many objects of interest which the mechanical skill and industry of Birmingham afford, the present will excite not the least interest or gratification. We may, perhaps, here observe, that the Messrs Evens have also executed a very ingenious design of an envelope, which seems admirably adapted for meeting the views of government in the contemplated change about to be made by the adoption of Mr. Rowland Hill's plan of a uniform penny postage. Specimens of this design have been forwarded to the Chancellor of the Exchequer for examination, and from the security which it affords against any successful attempt at forgery there appears great probability that it will be in part if not wholly adopted.—*Midland Counties Herald.*

Draining of Land by Steam Power.—The draining of land by steam power has been extensively adopted in the fens of Lincolnshire, Cambridgeshire, and Bedfordshire, and with immense anvantage. A steam engine of 10 horse power has been found sufficient to drain a district comprising 1,000 acres of land, and the water can always be kept down to any given distance below the plants. If rain fall in excess, the water is thrown off by the engine; if the weather is dry, the sluices can be opened, and water let in from the river. The engines are required to work four months out of the twelve, at intervals varying with the season, where the districts are large; the expense of drainage by steam power is about 2*s.* 6*d.* per acre. The first cost of the work varies with the different nature of the substrata, but generally it amounts to 20*s.* per acre for the machinery and buildings. An engine of 40 horse power, and scool wheel for draining, and requisite buildings, costs about 4,000*l.*, and is capable of draining 4,000 acres of land. In many places in the fens, land has been purchased at from 10*l.* to 20*l.* per acre, which has been so much improved by drainage, as to be worth 60*l.* to 70*l.* per acre. The following list shows the number of steam engines employed for this purpose in England: Deeping fen, near Spalding, Lincolnshire, containing 25,000 acres, is drained by two engines of 80 and 60 horse power. March West fen, in Cambridgeshire, containing 3,600 acres, by one engine of 40 horse power. Misserton Moss, with Everton and Graingley Carrs, containing about 6,000 acres, effectually drained by one engine of 40 horse power. Littleport fen, near Ely, about 28,000 acres, drained by two steam engines of 30 or 40 horse power each.

Before steam was used there were 75 wind engines in this district, a few of which are still retained. Middle fen, near Soham, Cambridgeshire, about 7,000 acres, drained by an engine of 60 horse power. Waterbeach level between Ely and Cambridgeshire, containing 5,000 acres by a steam engine of 60 horse power. Magdalen fen, near Lynn, in Norfolk, contains upwards of 4,000 acres, and is completely drained by a steam engine of 40 horse power. March fen district, Cambridge, of 2,700 acres, is kept in the finest possible state of drainage by a 30 horse power engine. Feltwell fen, near Brandon, 2,400 acres, by an engine of 20 horse power. Soham Mere, Cambridgeshire, formerly, (as its name implies,) a lake of 1,600 acres, drained by a 40 horse power engine, the lift at this place being very great.—*Lincoln Paper.*

*Railways in Germany.*----That part of the Taunus railway which lies between Frankfort and Hochst was opened on the 7th inst. The first train started at five in the morning. The two places, formerly two hours assunder have been brought within a distance of eight minutes of each other. On the same day (the 7th) the Emperor Ferdinand's railway, from Vienna to Brunn a distance of about nineteen German (eighty-five English) miles, was opened with great solemnity. The first train performed the distance in a few minutes over four hours. The day appears to have been celebrated, particularly at Brunn, as a civic feast, and the tickets which had been sold were disposed of by the first purchasers of them at a considerable advance, to those who were anxious to be able to boast that they had been among the first travellers by the new railway. We regret to find that the day did not pass over without an accident. In the evening, as one of the returning trains had stopped at a station to take in water, the locomotive engine of the train next in succession ran into the hindermost carriage, by which means several persons were seriously hurt, though none dangerously. The engineer, to whose carelessness the accident was attributed, was immediately placed under arrest.

*Manchester and Birmingham Railway.*—-The viaduct across the valley at Stockport, one of the heaviest contracts on the line, is now rapidly progressing. This work consists, in part, of 23 arches of 63 feet span. These arches, or rather the centres on which the arches are to be turned, require 3,500 cubic feet of timber for the construction of each, and there are to be eight arches completely finished before the centre of the first is struck. It will therefore, require 30,000 feet of timber in the construction of this part of the work. The brick work is three feet in thickness. The highest arch will overtop Mr. Ferneley's seven story mill about 12 feet.----*Staffordshire Advertiser.*

*Liverpool and Manchester Railway.*----The fifteenth half-yearly meeting of the shareholders was held on Wednesday, the 24th July. By the balance sheet it appears that the total receipts for the half-year ending the 30th of June, 1839, were 123,814*l.* 6*s.* 8*d.*; the expenses 75,602*l.* 7*s.* 1*d.*; giving a nett profit for the half-year of 48,211*l.* 19*s.* 7*d.*; to which is added 5,089*l.* 15*s.* 8*d.*, balance from the last account, leaving a disposable sum of 53,301*l.* 15*s.* 3*d.* From which sum the directors recommended a dividend of 4*l.* 10*s.* per share, amounting to 49,023*l.* 4*s.* 6*d.*, leaving a balance of 4,278*l.* 10*s.* 9*d.* to be carried to the credit of the next half-year's account, which proposition was unanimously agreed to by the proprietors.—-*C. E. & A. Journal.*

*Description of a new railway wheel, by Mr. Cottam.*—The wheels suggested are made on the following principles: 1st. They are wholly of wrought iron, so welded together, that, independent of screws, rivets, or any other kind of fastening, they form one piece with the spokes. 2nd. The spokes of the wheels are placed diagonally, and act as trusses, thereby giving the greatest possible support to the rim, or tire, and at the same time being in the best position for resisting lateral pressure. 3d. Iron in a state of tension or compression, as is usually the case with the tires of wheels, is easily broken by sudden shocks, or by vibratory action. The wheels in question are so constructed, that the fibres of the iron employed are neither compressed nor stretched, but remained in their natural condition. 4th. The strength of iron being as the square of its depth, then the flanged tires of these wheels, which offer sections twice as deep, are consequently four times as strong as those of any wheels at present in use. This increase of strength is attributable solely to the peculiarity of their construction, and not to any increase in the weight of the material. 5th. The spokes strike the air edgewise, and thus offer the least possible resistance. Wheels where the spokes present a flat surface may be said to act as blowing machines, and, as such, require greater propelling power. 6th. These wheels by simply varying the curve of their spokes, become either rigid or flexible, or in other words, they may be made to any degree of elasticity. 7th. When worn by friction, the rims or tires may be turned down, and have hoops of railway tire shrunk on them. Thus repaired, these wheels are very strong and durable, and more advantageous than those of other constructions.

Mr. Roberts spoke to the successful use of cast iron wheels, which, properly manufactured, he had never found to fail. The most important consideration to be attended to was the absence of oxide of iron, and if any was on the metal it must be removed by a file. If this precaution were attended to, there would be little fear for the stability of cast iron wheels. Mr. Woods stated that on the Liverpool and Manchester railway cast iron wheels were much used. They had employed wheels with wooden tires at the opening of that line, some of which were still in use; and so satisfied were the directors, that it was their intention to have some new wooden wheels made, and to submit them to the test of expertment.

*Gigantic Tunnel.*—Zanino Volta, an Italian engineer, has brought forward a plan for a railway from the lake of Zurich to Como, to join the Lombardo Venetian railway. He proposes to pass the Grison Alps by a long tunnel, which, from his survey, he hopes to be able easily to carry through the granite rocks. M. Volta proposes to form the rails of the granite, which is of a good quality. Two cantons have already given their approbation to the plan, and the engineer hopes to obtain sufficient support to be able to carry it into execution.

*Roman Causeway.*—Some works for improving the channel of the Scheldt have necessitated several extensive cuttings across the old Roman causeway, called La Chausee de Brunehaut, which connects in a straight line, the towns of Bavay and Tournay. These cuttings took place on the spot described in the itinerary of Antoninus as the Pons Scaldis. In the course of the work there have been discovered, on various points remains of constructions and large quantities of materials, which indicate the scite of a town or large village, and it appears that in this locality several bridges had been thrown over the Scheldt. This discovery shows that the point given by antiquaries as Pons Scaldis, was not merely a bridge over the Scheldt, but a Roman station which was probably fortified.

For the American Railroad Journal, and Mechanics' Magazine.

METEOROLOGICAL RECORD FOR THE MONTHS OF JULY and AUGUST, 1839.

Kept on Red River, below Alexandria, La., (*Lat.* 31.10 *N.*, *Long.*, 91.59 *W*)

| 1839 | THERMOMETER. | | | | | REMARKS. |
|---|---|---|---|---|---|---|
| Sept. | Morn. | Noon. | Night. | Wind. | Weath. | |
| 1 | 69 | 87 | 82 | calm | clear | |
| 2 | 70 | 84 | 78 | .. | cloudy | all day |
| 3 | 60 | 87 | 80 | NE | clear | |
| 4 | 68 | 88 | 82 | SE | .. | |
| 5 | 68 | 89 | 85 | .. | .. | |
| 6 | 74 | 82 | 80 | SW | cloudy | light showers at noon and afternoon |
| 7 | 78 | 91 | 86 | .. high | clear | all day |
| 8 | 80 | 90 | 79 | .. light | cloudy | at 10 a. m. fine shower |
| 9 | 84 | 74 | 74 | .. high | .. | at 12 shower |
| 10 | 70 | 82 | 76 | NW | clear | |
| 11 | 66 | 80 | 72 | NE | .. | |
| 12 | 69 | 82 | 75 | .. | .. | |
| 13 | 66 | 80 | 73 | N | .. | |
| 14 | 62 | 82 | 70 | calm | .. | smoky all day sunshine dim |
| 15 | 61 | 84 | 78 | .. | .. | foggy morning day clear weather smoky sun- |
| 16 | 67 | 89 | 80 | SW | .. | [shine dim |
| 17 | 68 | 89 | 82 | calm | .. | |
| 18 | 70 | 90 | 82 | .. | .. | |
| 19 | 62 | 85 | 80 | .. | .. | |
| 20 | 60 | 86 | 80 | .. | .. | |
| 21 | 62 | 86 | 81 | .. | .. | |
| 22 | 61 | 87 | 80 | .. | .. | |
| 23 | 68 | 85 | 79 | .. | .. | |
| 24 | 69 | 73 | 73 | SW | cloudy | at noon light showers and distant thunder |
| 25 | 68 | 80 | 76 | calm | clear | |
| 26 | 67 | 79 | 76 | .. | .. | |
| 27 | 70 | 72 | 74 | NE | cloudy | |
| 28 | 66 | 76 | 74 | calm | clear | |
| 29 | 64 | 76 | 72 | .. | .. | |
| 30 | 62 | 77 | 73 | NE | .. | |
| | 64.5 | 83 | 78.7 | ............ | ............ | mean temp. of the month 75. |
| Oct. | 57 | 81 | 78 | calm | clear | thick smoky weather |
| 1 | 58 | 81 | 78 | .. | .. | |
| 2 | 60 | 82 | 77 | .. | .. | foggy morning |
| 3 | 60 | 81 | 75 | .. | .. | |
| 4 | 66 | 86 | 81 | S | .. | |
| 5 | 71 | 86 | 81 | SE | .. | evening cloudy |
| 6 | 71 | 80 | 73 | .. | cloudy | light showers in the evening |
| 7 | 76 | 84 | 79 | .. | clear | |
| 8 | 74 | 78 | 78 | E | cloudy | drisling and light showers in forenoon heavy |
| 9 | 74 | 74 | 75 | calm | .. | all day and light showers [rain at night |
| 10 | 69 | 80 | 74 | .. | clear | all day |
| 11 | 66 | 82 | 78 | .. | .. | |
| 12 | 68 | 82 | 76 | .. | .. | |
| 13 | 62 | 82 | 76 | .. | .. | |
| 14 | 62 | 82 | 70 | .. | .. | |
| 15 | 64 | 78 | 70 | .. | .. | |
| 16 | 63 | 76 | 70 | W | .. | |
| 17 | 57 | 76 | 74 | .. | .. | |
| 18 | 58 | 77 | 69 | .. | .. | |
| 19 | 59 | 76 | 78 | NE | .. | |
| 20 | 57 | 74 | 68 | .. | .. | smoky weather |
| 21 | 60 | 78 | 70 | .. | .. | |
| 22 | 66 | 79 | 74 | S | .. | |
| 23 | 67 | 80 | 78 | .. | .. | |
| 24 | 71 | 84 | 78 | SE | .. | |
| 25 | 70 | 81 | 78 | calm | cloudy | |
| 26 | 72 | 80 | 75 | NE | .. | |
| 27 | 65 | 75 | 72 | N light | clear | |
| 28 | 55 | 70 | 65 | .. | .. | |
| 29 | 51 | 72 | 64 | calm | .. | |
| 30 | 54 | 75 | 64 | .. | .. | |
| 31 | | | | | | |
| | 64 | 79 | 74 | ............ | ............ | mean temp. of the month 73. |

*Engraving on Marble.*—Mr. Rayner, of Derby, has made a discovery in art; a new method of engraving on marble. Some of his pictorial efforts have elicted great admiration. Her Majesty is in possession of a variety of specimens, and the nobility in England and France have introduced them into their drawing rooms.

AMERICAN

# RAILROAD JOURNAL,

AND

# MECHANICS' MAGAZINE.

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We think that we cannot better close this volume of our Journal than by offering some remarks on the present state of the Profession, and taking a retrospective view of the operations of the last year, and saying some few words on our own labors and future course.

The attempt to form an Institution of Civil Engineers, has, we are sorry to say, failed. We are not, however, without hopes that another effort, more successful, will soon be made. We have heard a variety of opinions on this important project and, earnestly as we desire its success, we must admit that there are difficulties in the way, which it is much easier to point out than to overcome. In the first place it seems impossible to fix on any place where the leading members of the Profession could meet even once a year, far less every week, as in London. The public works of the United States are scattered over such an immense extent of country, that there is probably no point where even half a dozen Engineers, in charge of as many works, could meet even monthly. If we are right in this view, it is evident that the plan which succeeds so well in England, or rather in London, is not adapted without modification to this country. Then again the distinction between Members and Associates would lead to endless contention, though all will admit that some such division is both necessary and proper; but where to draw the line is the grand question. They who have held the rod, have carried the compass and level, have surveyed hundreds of miles for railroads and canals, and superintended the construction of not a few, are not pleased with the idea of being ranked with those who having failed as lawyers, doctors, storkeepers or office hunters "turn their attention," as the phrase is, to Civil Engineering, and who, in only too many instances, have at once received appointments to which they should have looked after five or six years arduous service in the field in the various grades of the Profession. More than one of our readers could with-

out much difficulty point out men in the situation of Residents or even higher, who would be puzzled if directed to take the Goniometer into their own hands and run out a curve of a given radius to join two tangents given in position, while the same feat constitutes one of the very easiest duties of their Assistants—the unpresuming title of those who do almost everything. There is a very large class of Assistants in the United States who from want of education or subsequent aversion to study or both, are unable to reach the highest stations of the Profession to which their long experience and practical skill fully entitle them. It is only when acting under men who combine liberal and scientific attainments with the proper experience, that this large class of eminently useful Engineers can ever attain their deserts, and it does appear reasonable to suppose, that they would derive great advantages from a well constituted Institution, where their industry skill and perseverance would be honorably registered by those who are alone capable of appreciating them. On the other hand, young men of superior talent or acquirements have only to offer original communications to the Institution, to be immediately known, and to be at once installed into the very position to which they are by their merits entitled, being neither ruined by injudicious flattery nor chilled by neglect. How different are the means by which a young Engineer now seeks to rise in his profession, on the Government works, in which are included nearly all the works of this country. His political creed, and the number of votes he and his friends can command, would far outweigh the professional claims of a rival who might unite in himself the genius of all the Engineers of the age; and this is the grand obstacle to the advancement of the Profession in the United States.

We will briefly allude to the manner in which many works are "got up," more especially in the Western States. A "celebrated Engineer" is employed to survey a railroad from 100 to 500 miles long; he makes a "highly favorable report" to the Legislature, on the strength of which they "authorise a loan" and "locate the line," though it is known to every well informed man in the State, that the work cannot be put into operation for less than 3 or 4 times the original estimate, and when it is capable of demonstration, that the country cannot possibly furnish business enough to keep the work in repair and pay interest on the loans, far less pay anything towards diminishing the debt, until the population has increased at least ten fold—say in from 50 to 100 years. Now it is obvious, that such men as Brunel, Stephenson, Walker, and a host of others in England, and we are proud to say, not a few in this country, whom we do not feel ourselves at liberty to name, are found utterly impracticable in such cases, and they are consequently avoided with as much care by the projectors of works to be built on the credit of the government, as they are zealously sought for by those who project works to be executed by the expenditure of their own actual capital. The evil of employing men incompetent from want of education, practice and character eventually recoils on the State; hence the financial difficul-

ties of all the States who have largely embarked in the construction of public works.

The State of New York furnishes some very instructive examples. By dint of much management a law was passed some years since, that, if a certain canal could be made for a million of dollars, it should be forthwith undertaken by the State. An Engineer was immediately employed to survey the route, and he reported, that the work could be constructed for nine hundred and ninety odd thousand dollars, though this was only at the rate of one half the actual cost of a similar canal, presenting fewer Engineering difficulties, which had just been completed. The insufficiency of the estimate must have been as well known then, as now, still, the law had passed and the Engineer had reported "favorably," so the million was spent, and a million and a half more was then required to complete the canal in the cheapest manner. Three years after handing in an estimate for the enlargement of the Erie canal, the following reasons are given for requiring 100 per cent additional. "A uniform plan" was not "adopted in the estimates" "and not much reflection had probably been bestowed on the particular manner in which the work should be done" (Assem. Doc. No. 339, p. 13, 1839.) It is also very properly observed (pp. 24 and 25,) that frost is a very destructive agent in Northern climates, that a large canal requires stronger banks than a small one and that work done in the winter costs more than in summer—all which would have readily suggested itself to individuals about spending their *own* money, even had it escaped the penetration of *their* Engineers for two or three years.

Again, the Croton Water works, nominally city works, though such no further than that the city pays for them, will contribute their mite towards developing the wonderful facility with which government Engineers adapt professional opinions to the wishes of government Commissioners. We must premise that the Water Commissioners had, till last year, delayed fixing on the plan for crossing the Harlem river, the most difficult and important work on the whole line. The plan then brought forward was opposed by certain proprietors of lands on the river, and the Legislature decided unanimously against the Commissioners, though the party to whom they owed their existence had a large majority in one branch—a case nearly unparalleled in New York legislation. The use of iron pipes for crossing, by means of an inverted syphon, the Commissioners' plan, was unnecessary, with the high bridge prescribed by the Legislature, but, as the former are as averse to being interfered with as they are prone to interfere with others, they have announced their intention of complying with the law no further than absolutely necessary, that is, they will keep the aqueduct 12 ft. below grade and use the pipes. We quote their own words.

"The bill as revised, * * * is in substance as follows:—The aqueduct to be constructed over the Harlem river, with arches and piers, the arches in the channel of said river to be at least 80 feet span, and *not less* than 100 feet from high water mark to the under side of the arches at the crown."

"The original design of a high bridge, as designated in our report of January, 1838, required arches of 112 feet in the clear above high water mark, which is 12 feet more than

that required by the act of May, 1839. A bridge therefore, of 100 feet height of arches above tide, will have to be passed by iron pipes, or syphons, to accommodate the ascent and descent of the 12 feet from grade. This bridge will be more economical in its construction, and not subject to so many contingencies, from its less elevation, as the plan originally proposed. The parapets will only be 114 feet in height, which is 17 feet lower than the plan of 1838; and as the arches are thus reduced in height, stone of a diminished thickness may be used. It is proposed to carry the water over the river, at the commencement of supply, by two three feet pipes, adopting the work however, to carry two pipes of four feet diameter, when the city shall require it. *The same arrangement for pipe chambers, and waste cocks, will be required in this structure, as was required for the syphon bridge formerly proposed.*"

"In relation to the bridge, the law prescribes that the arches in the channel *shall be* 100 feet at the under side of the crown, above common high water mark of the river, and *not less* than 80 feet span—conforming in these respects, we are at liberty to make the plans in all others, without restriction from the law."

"The arches of the bridge originally designed to maintain the grade of the aqueduct, were elevated 112 feet above the high water mark of the river, which is 12 feet higher than the *Act requires.* It is obvious, therefore, that 100 feet will not be sufficient to maintain an aqueduct of masonry, but *will require* iron pipes as conduits for the water. This I do not consider an objection, as I am fully satisfied, iron pipes will make the most suitable conduit for the water on such a bridge, and therefore have had a plan prepared, with a view to comply with the law, and avail of the economy and greater permanence from a less elevated structure. The less height required for the arches, and by adopting iron pipes for the conduit, the top of the parapets will be 114 feet above high water mark, which is 17 feet lower than the original plan. The superstructure being lighter than necessary for an aqueduct of masonry, a *diminished thickness* of arch stone may with equal safety be adopted."

We should be pleased to know what diminution in the depth of the arch-stones this change of plan would justify, as well as the saving in cost, which latter, we strongly suspect, it would be difficult to express in the constitutional currency of the United States, without an extension of decimals several places to the right of "mills."

The following extracts, though trifling in themselves, go far to show the estimation in which the profession is held by Government Commissioners.

"Notwithstanding the oversight of the Inspectors and Engineers, the work will, in a few cases, be carelessly performed; and it is only by the correcting influence of these repeated tours of inspection, made by the Commissioners and principal Engineers, that we can be certain the work is performed in a manner which will ensure its stability and imperviousness."

If the citizens of New York have no better guarantee than this, that the work has been faithfully superintended, that 4th of July on which the Croton water will be "regaling the taste and sight of our citizens," (p. 133) will be simultaneous with the milennium.

At p. 255, April number 1839, Railroad Journal, will be found the following cool assertion.

"The locks on the Chenango canal, which are 114 in number, are (with the exception of five stone locks) all of them composite. They were built under the direction of Mr. Bouck, one of the present canal Commissioners, and their average cost was $3,808 50 each."

We shall next be informed that the piers of the Potomac aqueduct have been successfully carried up under the direction of Mr. Forsyth, and that the Thames Tunnel has at length been completed under the superintendence of his prototype Lord Melbourne.

We refer to these circumstances only as effects of the policy of allowing the government to enter into the pursuits of individuals, and not with the design of insinuating that the mortifying reports of many government Engineers are the *cause* of the present state of the profession, but simply to show that they are the legitimate consequences of the pernicious interference of the State Governments with that in which they have no more right to engage, than they have to establish theatres or hotels and then forbid any citizen from competing with them, on the miserable plea, that all the people of

the State are interested in their tavern-keeping monopoly, that it bears equally on all and is, to use the logic of governments, *therefore* just. The pecuniary difficulties in which most of the States who have engaged in railroad and canal speculations find themselves involved, will necessarily break down the entire system of State works, and their complete abandonment will, more than every thing else conduce to the welfare, honor and usefulness of the profession.

The success which has attended the expensive and well constructed railroads about Boston, is the most encouraging facts we have to record, and it is worthy of remark, that the stocks of those roads were the only stocks not affected by the bursting of the biennial bubble, grandiloquently called the "late crisis." The Eastern railroad has been opened to Salem, and the number of passengers is already twice that estimated before the opening of the road, and on which the project was based. The Western railroad has been opened as far as Springfield. The Old Colony railroad is going on rapidly; the Norwich and Worcester is to be opened about new year's day, and the Housatonic railroad some time this month. In this State, the Utica and Syracuse railroad has been opened, and the Syracuse and Auburn railroad put into full operation. In Pennsylvania, the Reading railroad has just been completed, and in Maryland, we believe the Baltimore and Susquehannah railroad has been opened to the public. Two of the above roads have received aid from the State of Massachusetts, but they have all been managed, and, with these comparatively trifling exceptions, have been paid for by individuals. *We do not know of a single State work having been completed, or in part opened during the year* 1839.

In New England they have retained too much of the sturdy independence and common sense of their forefathers, to tolerate the meddling of the government in the affairs of individuals, and we seek in vain for a canal, a railway, a machine shop, a lumber or coal yard owned by a New England State. It has been found impossible to persuade them that they are not as capable as their Transatlantic brethren of managing their own affairs, and the consequence is, that they have the best managed, best constructed, most costly and most successful railways of any State in the Union. An attempt has been made to regulate the sale of spirits, and has proved about as successful as a previous effort to interfere with another article in the "grocery line"—y'clept "tea."

Some little has been done on the State works of New York, by means of the unexpended balances of former appropriations for the enlargement of the Erie canal and the construction of the Genessee valley and Black river canals. There is no little curiosity to know how the first is to be disposed of —not only both parties, but every sane resident of the State, who feels an interest in her honor and welfare, being heartily ashamed of his credulity in believing it either practicable with the means of the State, or useful even if practicable. The money already thrown away on this unrivalled specimen of legislative folly, will do something towards opening the eyes

of the citizens of this State, and a year or two hence we fully expect to find the enlargement as unpleasant a reminiscence in New York as the suspension is in a neighboring State.

The lateral canals of the State of New York cannot with propriety be passed by, being "par excellence" government works in their conception, management, and income. As the official report on the Genessee valley canal has been published in this Journal, (15th April, 1839, p. 253, et seq.,) we will examine the proceedings of the Commissioners with regard to that work, and our readers, by turning over their files, will be enabled to judge of the accuracy of our deductions. The original estimate of the canal was a little less than two millions, but the present estimate is thus stated in the report alluded to.

"The cost of the canal [excluding $314,520 43 for the Dansville branch] is estimated by the canal Commissioners in their recent report, [Assembly Document of 1839, No. 360,] at $4,585,602 36.

"The canal board are not possessed of all the facts necessary to enable them to estimate with sufficient certainty the future revenues of the canal. They fully appreciate its value to the interesting section of the State whose resources will be developed by its completion. In respect, however, to the tolls to be derived from it in the present state of the navigation of the Alleghany river, the board would observe, that in the year 1835, F. C. Mills, Esq., the Engineer who surveyed the route, submitted an estimate to the canal Commissioners of its probable revenues, [Assem. Doc. of 1835, No. 264, page 42,] in which he computed the tolls, independent of its probable contributions to the Erie canal, at $39,129 60. Of this amount, $13,207 was estimated for the tolls on the finer qualities of lumber and other products of the forest, which, it was supposed, would seek the New York market in preference to that on the Ohio and Alleghany rivers. A majority of the canal Commissioners, [including the late acting Commissioner on that canal,] in the report above referred to, have expressed their belief that the amount of $39,129 60, is "greater than will be realized for at least the first few years after the canal is completed."

Now let us translate this into plain unofficial English, such as is used in the every day transactions of common men, not devoid of common sense. It is proposed to construct a work at the expense of the State the cost of which is estimated at two millions of dollars and its *gross* income at less than $39,000, one-third of it to be derived from lumber, which it is well known, will soon be exhausted. The canal is to be 106 miles long, and we know from experience that $39,000 will not meet the ordinary annual expenses, repairs and renewals. We will, however, suppose this sum sufficient for those purposes, then the people of this State are saddled with a "gentleman pensioner," who cannot exist on less than $100,000 per annum. On comparing this, however, with the Chenango canal, it was discovered that the annual deficits of the latter exceeded those of the former by $20,000, and as the march of the Commissioners was "still onward," they at once decided on such an addition to the estimate as should place the Genessee valley canal as far "ahead" of the Chenango, as the latter was in advance of the other "auxiliary" canals. They determined accordingly on spending five millions on this work, which will entail on the State a permanent annual tax of $250,000 at least.

Now, does any man, out of office, believe that the people of the State of New York would have authorised an expenditure of five millions of dollars on a canal which its friends and projectors assert will not yield more than $39,000 gross revenue, merely for the privilege of having their money squandered by a set of canal Commissioners? Before seriously enter-

taining such a project, far less recommending it, they ought to have been able clearly to establish the probability of an immediate income equal to

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|---|---|
| Annual cost of repairs, renewals and expenses, | $50,000 |
| Interest on five millions of dollars, | 250,000 |
| Towards paying off the debt, at least, | 100,000 |
| Making the total minimum income, | $400,000 |

or ten times the estimated income, the latter being in fact, too insignificant in amount to have any material bearing in discussing the value of an undertaking which is to cost five millions.

Suppose that the State of New York, after expending one million on the Chenango canal, had refused to submit to any farther imposition—that canal would have been unfinished—its revenue nothing, in place of $20,000 or an expenditure of two and a half millions, practically speaking, nothing —the State would have saved one and a half million and would only have incurred a permanent annual tax of $50,000 instead of $120,000 which the people of this State are now paying for the glory of owning the Chenango canal. We give an extract from an article which appeared in the Courier and Enquirer of 7th May last, in which the writer undertakes to prove that lateral canals generally will be nearly useless in themselves, and of little value to the main canal. Whatever may be thought of his *reasons*, it is only too true that his conclusions are fully borne out by the actual experience of this State.

"I have never seen any attempt to explain the causes which render the lateral canals unable to pay expenses, though it appears to me to be by no means difficult. The policy which led to the construction of these lateral or auxiliary canals, has no analogy with that which influenced and guided the projectors of the Erie and Champlain canals. The immediate object of the former, was to open to the husbandman the extensive and fertile region of western New York; that of the latter, to bring within reach of the city the forests of the north. Both have fully succeeded—not because there are no other such routes "in the world"—but because they were projected in such a manner as to open the greatest possible extent of country and without reference to mere local interests. With the lateral canals the case is widely different, for it is evident, that the main canal will command the business of the country through which it passes, for a certain distance on each side, this in an agricultural country, will vary from 25 to 40 miles according to circumstances; but, whatever distance be allowed, it is clear, that the portion of the lateral canal contained within these limits, will only receive the contributions of those directly on its banks. If the lateral canals be from 80 to 100 miles apart, it will be found, by a few simple calculations of distances, that a very small portion of the country between the lateral canals and within 40 miles of the main canal will derive any advantage from the lateral canals. Hence the insignificant revenue of the Seneca, Crooked Lake, Chemung and Chenango canals. The two first are in the country directly tributary to the Erie canal, one helf of the Chenango canal is liable to the same objection, and the other half and the Chemung canal would suffer from the New York, and Erie railroad had they more than a nominal revenue. The Black river canal proper lies within the influence of the Erie canal, and its extension to the Lake or the St. Lawrence will only furnish a slower more expensive and more troublesome communication between its termini, than the present excellent one by Lake Ontario and the Oswego canal. Lastly, the Genessee valley canal, with the Erie canal on the north and the Erie railroad on the south, bids fair to be second only to the enlargement in disposing of the surplus revenue, or rather in adding to the vast annual deficiencies, which nothing short of an entire change of policy can possibly avert. If the Black river and Genessee valley canals estimated at ten millions, be immediately abandoned, the State will lose about $500,000, which may be considered an anticipation of the payment of one year's deficiencies of these canals when completed, by the immediate forfeiture of which, the State will save a like expenditure per annum in perpetuity, besides the immediate disbursement of a sum nearly equal to the entire cost of the Erie and Champlain canals."

The estimates for these canals have since been reduced, and their probable deficiencies are estimated by Mr. Paige (Sen. Doc. 1839, No. 101, p. 7.) at $450,000, and if the sum now spent on these works does not exceed

two millions, their immediate abandonment will save the State $350,000 per annum—a sum more than sufficient to support the government. We shall have occasion again to refer to the above report, which contains the most sensible view of the public works owned by this State, which has fallen under our observation; and it derives great value from the circumstance that the writer is justly considered one of the ablest men of the party to which we are indebted for the lateral canals and the enlargement, and would naturally be disposed to treat them in the most favorable manner.

It is assumed by Mr. Verplanck and the committee of 1838 that the revenue of the Erie canal will justify an expenditure of 40 millions, and repay the principal in 30 years; while, on the other hand, Mr. Paige, from official documents, undertakes to prove that the revenue will only pay the interest on 15 millions, with every prospect of a permanent debt to that amount. This great discrepancy arises from the fact that Mr. V. adopted the views of the committee of '38, who state in their report, (see Railroad Journal, 1839, p. 87.)

"It will be perceived that the very foundation upon which the financial calculations of the committee are based, is the estimate of the canal Commissioners submitted to the Legislature, in which they state that the Erie canal, within a few years after its enlargement, will produce an annual revenue of $3,000,000. The importance of verifying the accuracy of this estimate will be evident, as any material error would lead to the most injurious consequences."

Mr. Paige on the other hand instead of adopting the conclusions of the Commissioners takes the data on which they either did or ought to have established their income of three millions, and demonstrates that there is no probability of the revenue of the Erie canal reaching this sum till the year 1886 without making any deduction for the partial or total repeal of its monopoly of carrying freight on which exclusive privilege it was shown in a former number that its *entire surplus* revenue depends. The Governor in his late message, as well as the committees of '38 and '39 have placed implicit confidence in the estimated income of three millions, as reported by the Commissioners, while Mr. Paige goes to work as if he neither knew nor cared about any previous calculations on that subject. We have no means of ascertaining why he who knew the merits of the Commissioners so much better than the other gentlemen, should not have yielded the same credence to their statements, but, be this as it may, he has shown clearly that the estimate of three millions gross income from the Erie canal, is utterly unworthy of belief. We must, however, correct one error in this excellent report. It is said, (p.8,) "The Commissioners cannot be regarded as estimating that the tolls would amount to $3,000,000 in 1846 or 1849, but at a period much more remote." This unhappy attempt at exculpation had been anticipated by the report of the late Comptroller which appeared more than three months before the report of Mr. Paige. This officer writes and italicises the remark, (No. 4, Ass. Doc. p. 23,) "*A few years after the completion of the enlargement* may carry us to 1850."—The door of escape for the Commissioners, is therefore closed and we are at liberty to choose as we please,—Mr. Paige's estimate of three millions

revenue in 1886 or the Commissioners' estimate of three millions revenue "*a few years*" before 1850.

After proving the inability of the State to complete the enlargement and the consequent impropriety of any further expenditures, that same Senator, the best lawyer in that body, advocates the enlargement, merely reducing the size from 7 by 70 to 6 by 60, a distinction without a difference—for an expenditure which is wrong in principle cannot be justified by a diminution of its amount by four millions, or 16⅔ per cent. the precise amount leading to a long debate. The same course was also taken by another gentleman who is well known for the manly stand he has taken against lateral or, as he very properly designates them, "pauper canals," and thus we find two of the most able members of the Senate advocating a work which they know the State can never complete and can never require. As already remarked of the Engineers, it is their misfortune rather than their fault, and the inevitable result of the departure of the government from the high duties of general legislation and its illegal embarkation in the pursuits of individuals, for these same gentlemen, if members of a board of Directors who were expending *their own* money, would be eminent for sagacity, prudence and candor.

The Governor in his first message admits the evil, but does not, in our opinion, go to the foot of it, though, as it was necessarily written before entering on office, he could scarcely at that time have supposed it possible that he was approving of a system of works based on official data, which it is now only too clear, were never entitled to his confidence. He very truly observes (Railroad Journal 1839, p. 14.)

"With the extension of our internal improvements, there has been an immense and unlooked for enlargement of the financial operations and the official power and patronage of the canal Commissioners and the canal Board. These operations are conducted, and this power and patronage exercised and dispensed with few of those requirements as to accountability and publicity enforced with scrupulous care in every other department of the government. So inconsistent and unequal are the best efforts to maintain simplicity, uniformity and accountability throughout the various departments, that a greatly mysterious and undefined power has thus grown up unobserved, while the public attention has exhausted itself in narrowly watching the action of more unimportant functionaries. It is a proposition worthy of consideration, whether greater economy and efficiency in the management of our present public works would not be secured; a wiser direction given to efforts for internal improvement throughout the State, and a more equal diffusion of its advantages be effected by constituting a board of internal improvements, to consist of one member from each senate district."

This plan may be attended with some advantages for a short period, but the very nature of the tenure renders it impossible for the State to command the services of agents with the character, capacity, and acquirements of those employed by individuals and companies, as is only too apparent in this State, from the manner in which the enlargement of the Erie canal, and the construction of the Genessee valley and Black river canals have been "got up."

We will briefly allude to some of the Western States. In Michigan, a private company commenced the only important work which can, for many years, be projected in that peninsula—the Detroit and St. Joseph's railroad. The company however, could not proceed with sufficient rapidity, so the

State "assumed the mantle" of Engineer and forwarder general, and commenced the construction of a "Northern Railroad," a "Southern Railroad," one on eacy side of the company's road now the "Central railroad," and rendered the *system* complete by introducing the "Clinton canal" between the northern and central lines of railway. These four works average very nearly 200 miles each, the sum appropriated or rather the loan authorised for these 800 miles was five millions of dollars, or $6,250 per mile, about one-fourth of the sum required to put them into operation, yet the State has actually entered on the construction of all these works. The result is, that the State, after expending all she has been able to borrow, has only 40 miles of the Central (formerly company's) road in operation, her credit is gone for many years, her farmers must be directly taxed to pay the interest on money expended on works which will never be completed, and the *only* work really required is indefinitely postponed. As in the State of New York, the works projected by the government of Michigan were never thought of by private companies, and it would be as difficult to raise by *private subscriptions* to the stock, 5 per cent. on the probable cost of the "Northern railway," of the "Southern railway," or of the "Clinton canal," as it would be to induce individuals in the State of New York to contribute, as a permanent investment from *their own* means, 2 per cent. towards aiding the government in the construction of the Genessee valley and Black river canals or in the enlargement of the Erie canal—that is—impossible.

The State of Illinois received from Congress a valuable grant of land to aid in the construction of the Illinois canal, a truly national work, uniting the Mississippi with the Atlantic by the St. Lawrence and Hudson rivers. This donation would have enabled the State to complete the canal and the nett revenue might have been expended in aiding private enterprise without the possibility of any tax being necessary even if all the works which they aided should be as unproductive as the "lateral canals" of New York. *Now* they have commenced a "system" of railroads the aggregate length of which is above 1200 miles! besides other works. It is unnecessary to state the consequences which have followed, any further than to allude to the sale of the State stocks in New York at 50 per cent. and to the special session of the Legislature which has been called to devise "ways and means" to enable that State to meet its immediate obligations. There is much anxiety to know the course likely to be persued by the governments of Pennsylvania, Illinois and Michigan, and last, though not least, the city of New York. The Croton water works are exactly as far from completion as when ground was first broken, for the work which, with *any* quantity of money would require more time than *all the rest*, has just been commenced! Had the Commissioners invested the insignificant sum of $2 or 300,000 from their *own* capital this would neverhave occurred, and had this undertaking been left to a company, who should have been bound to expend 20 per cent. on the cost of the work from their *own* means, the citi-

zens of New York would be supplied with "pure" water many years sooner and at one-third of the cost, which now appears inevitable.

In some States, the grand argument will be, that if they can only *complete* the works commenced, a revenue is immediately certain, which will render taxation to pay the interest unnecessary. That the completion of these projects will make the fortunes of many individuals, is well known, but, for the *permanent interests* of the State, the only plan is, to sell out at once with the present comparatively trifling loss It is impossible to pay too much attention to the fact, that the greater part of the works projected by the governments of the different States are not such as will ever be of any essential benefit, and, when we add to this, that they are constructed at twice the cost of similar works in the hands of companies, are generally much inferior in execution and always managed and repaired in the most inefficient manner—we shall be at no loss to account for the present condition of State works in general. The deficiencies of this year in Pennsylvania alone, are estimated at $1\frac{1}{2}$ millions of dollars, and except the Erie canal, there is not a government work in the Union which has paid the ordinary expenses, including of course, interest on cost. If the Erie canal be placed on the footing of the canals of Pennsylvania, that is, if its exclusive right to carry all the freight to and from, western New York, the western States and Upper Canada be abolished, the gross income of the canals of New York will bear a less proportion to the expenditures, than does the revenue of the public works of Pennsylvania to the annual outlays on the Internal Improvements of that commonwealth. Notwithstanding their financial embarrassments, we are happy to say, that no other State in the Union has resorted to this mode of giving a "delusive prosperity" to their public works, and there is some reason to believe that the long reign of "exclusive privileges" in this State, is about to close. By making immediate arrangements for retiring from the construction of canals, the State of New York may yet escape with trifling loss, and with this object in view, the people would readily submit to the present monopoly of freight from the north and west for a few years longer. This appears to us the most judicious course to be pursued in order to avoid a permanent debt, and it certainly offers an honorable retreat from a position in which it is daily becoming more difficult to maintain ourselves.

The great efforts which have been made by the inhabitants on the line of the New York and Erie railroad, under the most discouraging circumstances, to aid in the construction of that undertaking, show that private en terprize is not yet extinguished in this State and we have to record the astonishing and gratifying circumstance, that—notwithstanding the different State governments have made every exertion to absorb all the spare capital of this country and of Europe for their own Utopian schemes—the year 1839 has seen more works completed by *companies* than by *States*. Private energy and enterprise have succeeded where the power of government

has been unequal to the task, and while the star of "free trade" floats triumphantly on the banners of the Bay State, and indeed throughout New England, we will not despair of seeing, in the Empire State, railways as judiciously projected, as well constructed, as profitable to the propretors and as useful to the public as those of Massachusetts when they shall be left equally free to the people of the former as they always have been to those of the latter State.

Our remarks on the grand question of the session—the railway through the southern tier of counties—will be given in the next number of the Journal, and we conclude this paper with stating our firm conviction, that no new canal will be undertaken by the States of New York, Pennsylvania, or Ohio, and that notwithstanding the complacency with which "repudiation" has been spoken of—we might even say threatened and almost advocated—in a certain high quarter, the people of every State in the Union will continue to act in good faith and fulfil their engagements, even if considerable sacrifices be necessary which is scarcely possible, unless they determine on carrying out, in the present sober times, the mad projects conceived in the frenzy of '36, which have been as injurious to the healthy progress of Internal Improvements, as to the cause of morality, industry, and honest enterprise.

☞ The first paragraph in the above paper was, by accident, in a part of our edition, erroneously printed, it should be as follows:—"Thinking that we could not better close the present volume of our Journal than by offering some remarks on the present state of Internal Improvements and the prospects of the Profession, we have requested a friend who is well qualified as a gentleman of education and an accomplished Engineer, to carry out the idea.

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## AMERICAN LOCOMOTIVE ENGINES.

A few days since, in company with one of the proprietors, we had the pleasure of a visit to, and inspection of, the very extensive works of Messrs. Rogers, Ketcham and Grosvenor, at Patterson, N. J., for the construction of various kinds of machinery. Our attention was of course principally directed to the shops for the construction of Locomotives, the main building of which is 200 feet long, and 3 stories high; and another of equal length containing near 50 forges, most of which were in operation, notwithstanding the "pressure of the times."

We saw a number of engines in different states of forwardness, and, though the general forms are those of 6 wheeled American engines in general, we were not a little gratified with several minor arrangements, new to us at least, which have been introduced by Mr. Rogers, and to which we will briefly refer.

The wire gauze on the smoke pipe is protected by an inverted cone placed in the axis of the pipe a few inches below the wire gauze. The base of the cone is curled over so as to scatter the sparks over a large portion of the sur-

face of the wire cloth, and to prevent the *top* of the spark catcher from being burnt out before the rest of the wire cloth is materially injured. It also tends to throw the larger sparks down between the pipe and the casing, and will do something towards diminishing this standing reproach.

The truck frames, whether of wood or iron, were admirably stiffened by diagonal braces, and where the crank axle is used, the large frame is very strongly plated, in the manner of Stephenson's engines, the neglect of which till very lately, has been, we are informed, a constant objection to the Philadelphia engines on the Long Island and Troy railroads.

The wheels are of cast iron, with wrought tires; the spokes are round, and they as well as the rims are hollow, except where the crank axle is used, when the rims are cast solid on one side so as to counterbalance the cranks. Our readers will probably remember an article on this subject, in the Journal, No. 7—8, page 244, of the present volume, on "side motion, or rocking," by G. Heaton, where its success on the Birmingham railroad, has been complete. Mr. Rogers balanced his *first* wheels two and a half years since, and two years ago entered a specification, not with the intention of taking out a patent, but to prevent any one else from doing so; and thus depriving the community of the benefit which Mr. Rogers was desirous of conferring; and which we understand other makers are now availing themselves of. The advantages are fully explained in the article above refered to.

When the crank axle is used the eccentric rods and the cranks of the rock shaft are placed on the *outside*, where they are easily got at, and where they are not crowded into the smallest possible space, as with the ordinary arrangement. For this a specification was also entered with the same object as in the preceding case. But we were most pleased with an arrangement of levers to which the eccentric rods are *fastened*, and thus the reversing depends on no contingency, for the rods are *forced* in, and out of gear; a *single* handle is only required to manage the engine much more rapidly, and efficiently than by the ordinary mode.

The boilers are 8 feet long, for an 8 ton engine, with 120 flues; the usual length of the former being, we believe, 7 feet, and the number of the latter, about 80 or 90. By this deviation the area of heating surface is increased, and the heat remains longer in contact with the flues, while the addition to the weight is very trifling compared with the advantages derived from the saving of fuel.

Mr. Baldwin, of Philadelphia, took out a patent some time since for a very ingenious mode of saving half the crank by inserting the wrist into one of the spokes of the driving wheels, and this has been very closely imitated by making one complete crank; and by letting one half of it into a spoke "which is cast larger than the others with a receptacle for that purpose." This latter plan has been adopted by Mr. Rogers and others in this neighborhood, whilst the Boston machinists aim at bringing the two cranks as near together as possible. The relative merits of straight and

cranked axles are so well pointed out in Mr. Woods' paper on locomotives, in these numbers, that we shall merely beg leave to state that the plan of Mr. Baldwin, and its imitation, appear to us to combine the liability to fracture of the crank axle with the loss of heat, the exposure to accident, and the racking of frame and road ascribed to the straight axle, for the only difference is, the thickness of the spoke. The loss of heat is the same in both, and the protection against any *serious* accident is too trifling to be considered, whilst with the cranks as close as possible the cylinders are completely protected. We offer these remarks as own views merely, and with all due deference to the superior skill and science of Messrs. Baldwin and Rogers.

Mr. R. in common with all other experienced machinists with whom we have conversed is decidedly opposed to any increase of width of track beyond 5 feet, with the *present* weight of engine.

As regards the power of the engines, they are able to slip the wheels when the rails are in the best state—this they do in common with all good American or English engines,—consequently any accounts of extraordinary performances would be worse than superfluous, when we *know* that they will do all that any other engine whatever, with the *same* weight on the driving wheels possibly *can* do.

As a last remark, we would observe that there is rather more finish on the engines of Messrs. Rogers, Ketchum and Grosvenor, than we are in the habit of seeing; some parts usually painted black being highly polished. On the whole we consider their new establishment eminently calculated to add to the reputation of American Locomotives, as it has for many years largely contributed to the character of American machinery for the manufacturs of cotton, and other objects.

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American Locomotives.—We give place to the annexed communication in relation to the performance of a locomotive engine, on the New Jersey railroad the more readily as it will serve hereafter as a performance for comparison. It is also acceptable at this time, as the engine is from a shop to which one of the editors of this Journal, in company with two friends made a visit of inspection a few days since, some account of which, will be found in this number of the Journal.

For the American Railroad Journal and Mechanics' Magazine.

Gentlemen:—As you seem to take a deep interest in the success of American locomotives, I will give you a statement for your gratification, in relation to a performance on the New Jersey railroad a few days since.

Owing to some circumstances, of which I am not informed, it became necessary for a locomotive on the way from Jersey city to New Brunswick, to take in addition to its own load, the cars attached to another engine which made the number equal to 24 loaded four wheel cars, and with as much apparent ease as could be desired, notwithstanding the grade, for four miles

is equal to 26 feet per mile, stopping on the grade to take in passengers, and starting again with the greatest ease. The average speed on the grade was 24½ miles per hour. This may not be in your estimation anything extraordinary, yet I consider it a p.rformance worth recording, by way of contrast with the *greatest and most extraordinary performance* of a locomotive ever heard of, *in those days*, which occurred on the Liverpool and Manchester railroad in 1829, only ten years ago. *Twenty tons*, on a level road at the rate of 10 miles per hour, was then considered wonderful! *astonishing!!* even in a country famed for its extraordinary discoveries; yet here, only ten years after, we see an engine, built in *this* country, too, taking a load probably equal—cars and tender included—to 120 or 130 tons at the rate of 24½ miles per hour, up a grade of 26 feet per mile. This engine was built, I understand, at Patterson, New Jersey, by Messrs. Rogers, Ketchum and Grosvenor, a concern not yet so well known to this railroad community as manufacturers of locomotives, as they ought to be, or as they will soon be, if they continue to turn out such machines as the one above alluded to.

If such have been the improvements in the *past*, what may they not be, permit me to ask, in the *next* ten years? Pardon me for thus troubling you, but my aim is rather to call attention to the rapid march of improvement in this mode of communication, than to direct attention to any individual, or company—although those gentlemen, in my opinion deserve as manufacturers, much more than I have said of them.

Yours, truly,

*Newark, N. J., Dec.* 14, 1839. JERSEY BLUE.

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Some time since, we were requested to publish the paper of Mr. Woods on Locomotive Engines which we conclude in this number. We have succeeded after some delay in procuring a copy of the Transactions of the Institution of Civil Engineers, and immediately proceeded to furnish such articles as may be of general interest to the Profession, that of Woods' being the first. We hope before another year has passed to be able to extract from the Transactions of an American Institute.

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☞ We wish to correct an error which appeared in our advertisement on the cover of the October number. We intended to advertise a "Treatise on Railway Curves, by *J. S. Van de Graaff*, not by the Chev. de Gerstner. It was an error of the printing office, therefore those gentlemen who have written to us, ordering the work, will please set it down as a slip of the *type* not of the pen.

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The Agent of the Railroad Journal having returned from his tour, embraces this opportunity of expressing his thanks to the Superintendants of the various Railroads upon which he has traveled for their courtesy in tendering to him the facilities of locomotion "without money and without price." He trusts that on subsequent *professional* visits, he may enjoy similar demonstrations of their good feeling.

## LOCOMOTIVE POWER APPLIED TO CANAL TRANSIT.

On the 21st and 22nd of August an experiment was conducted on the Forth and Clyde canal, of a novel end highly interesting nature, by John. Macneil, C. E.. and consulting engineer to the canal company. It is well known that the haulage of boats on this canal has hitherto been performed by horses, the rates of speed being for the heavy sloops, brigs, &c., in the London, Dundee, and other trades, about $1\frac{1}{2}$ to 2 miles per hour, when drawn by two or five horses, according to the state of the weather, and for the swift or passenger boats between 8 and 9 miles per hour, on an average when drawn by two horses. The object of the experiment was to ascertain the possibility of using locomotive steam power to draw the boats instead of horses: accordingly, a single line of rails, upon blocks, like an ordinary railway, was laid down for a considerable space along the canal banks, near lock 16; and a locomotive engine and tender, built by Mr. William Dodds, having been brought down the canal and set on the rails on the morning of the 21st, Mr. Macneil, Mr. Johnston, the canal director, and several engineers and gentlemen, being present, the experiment commenced by attaching to the engine the towing-line of the first passenger boat that made its appearance, and which contained upwards of 90 passengers, with their luggage. There was a trifling delay in disengaging the horses and tying the line to the engine, but this was amply compensated when the "Victoria" briskly set off, and almost immediately gained a speed of $17\frac{1}{3}$ miles per hour, which she kept up round two curves, and until the termination of the rails made it necessary to stop, amid the cheers of the delighted passengers. This experiment was repeated, during the course of the day, with each passenger boat as it came to the railed space, and with equal success each time. On one occasion a towing-rope, which was much decayed, got foul with a curb stone and broke; but without causing the slightest inconvenience, except about one minute's delay. The engine employed being intended only for a slow trade, was not calculated to go at a greater speed than eighteen miles per hour: but it was the opinion of all present, that with proper passenger locomotives, a speed might be obtained equal to that upon the best railways, few of the latter possessing the advantage secured by the canal bank of a *perfect level* throughout.

The nature of the motion was highly gratifying to all the passengers, being more uniform, steady, and smooth than when the boats were drawn by horses.

Several of the heavy (masted) vessels were also taken in tow during the two days of trial, at the rates of 3, $3\frac{1}{2}$, 4, and 5 miles per hour; and, on one occasion, two loaded sloops, and a large waggon boat, were together attached to the engine, and hauled with ease at the rate of $2\frac{3}{4}$ miles per hour, while only *one-fourth* of the steam was allowed to pass the throttle-valve.

The foregoing statements render palpably apparent the immense advantages which might be gained by this new adaptation of steam power—a great economy in haulage expenses, as one engine might draw at least 6 sloops, which now would require from eighteen to twenty-four horses, and, if necessary, at double the present speed; and a proportional increase of the important traffic on the canal, which might be reasonably expected.

Passengers would increase in a great proportion, when attracted by economy and speed of transport. The Union canal might be traversed in two hours, and the Forth and Clyde canal in one and a half, instead of four hours and three and a half, as at present, and this by only assuming 16 miles per hour, though more might easily be performed, as the experiments have shown.—*Glagow Courier.*

## THE IRON TRADE.

(Continued from page 340.)

The first works we reach are the Beaufort, which I have already informed you, belong to Messrs. Bailey, and their produce I have included in the return for Nant-y-glo.

Proceeding onwards, we arrive at the Ebbw Vale works, the property of Messrs. Harfords, Davies and Co., who are also the owners of the Sirhowey iron works, situated in the next valley. At Ebbw Vale they have three furnaces in operation, and are building a fourth. They blow one furnace with hot and two with cold air. These furnaces are very productive, yielding 100 tons per week each. At Sirhowey, they have four furnaces in blast, and one undergoing repairs; two are blown with hot, and two with cold air. These furnaces also make about 100 tons per week each, so that at the two works they make about 700 tons of cast iron weekly; the whole of which is converted into bars, rails and rods. Their make of malleable iron is from 600 to 630 tons per week.

One mile lower down the Ebbw Vale, you will find the Victoria Iron Works, recently established under the able superintendence of Roger Hopkins, Esq. These works belong to the Monmouthshire Iron and Coal Company. Only one furnace is yet at work, but another is ready to be blown in, and they are erecting two others. They have just commenced the manufacture of bar iron. I have been informed that they intend building ten additional furnaces, lower down the valley, near to Abercarne. When in full operation, they calculate on making 1000 tons of wrought or malleable iron per week; but this expectation will probably require a few years for its accomplishment.

Having seen all the works in the third valley, we proceed to the fourth, and we here find, first, the Sirhowey works, to which I have already alluded, and next to these, the works of the Tredegar Iron Company. At Tredegar, they have five furnaces in operation all blown with cold air; they are building two others, and contemplate the erection of two more, making nine altogether. They now produce 400 to 450 tons cast iron weekly, which is nearly all made into bars, rails and rods; of these they make about 330 tons per week.

We must now travel on to the fifth valley, in which we find only the Rhymney and Bute Iron Works, belonging to the joint stock company of that name. This is a very extensive and most valuable mineral property, and these works bid fair very soon to rival the largest establishment in South Wales. They have now six furnaces in blast, two blown with hot, and four with cold air; and they are building four others. They make about 550 tons pig iron per week, from which they produce 450 to 480 tons malleable iron in the same period of time.

The whole of the works we have visited since we left Newport, send their iron to that port for shipment, and it is conveyed chiefly down tramroads by locomotive engines and by canals.

We must now take a stretch of five or six miles to the westward, and this will bring us to the hitherto unrivalled establishment of Sir John Guest, Lewis, and Co., at Dowlais. Here you will find fifteen furnaces in full activity, and four others building. I find that I have omitted to note how many were blown with hot, and how many with cold air, but if my memory serves me correctly, I think five with the former, and ten with the latter. These fifteen furnaces make on an average 1350 tons of pig iron per week, nearly the whole of which is converted into malleable iron, say about 1000 tons bars, rails and rods per week. At this establishment they employ upwards of 4000 hands.

The next works we reach are those of the Pen-y-darran Iron Company. They have six furnaces in blast, and one out, making about 400 to 500 tons cast iron per week, and they convert nearly the whole of it into malleable iron, of which they produce about 400 tons per week. I believe the whole of these furnaces are blown with cold air.

We have now, gentlemen, performed a very good day's work, and I am sure you will heartily join me in a proposal to take up our quarters for the night at the Castle Hotel, at Merthyr Tydvil, where I give you my word that you may make yourselves comfortable if you choose. You must take care to muster for breakfast at eight o'clock to-morrow morning, and at nine we will go to see Mr. Crawshay, who is a very early man of business.

The preparation of the morning over, and our arrival having been announced at the Cyfarthfa office, we will now on our way to Cyfarthfa see the Iron Works belonging to Messrs. Crawshay and Sons, and shall no doubt be willingly accompanied by Mr. Williams, their talented engineer. These works are in my opinion the neatest and best arranged in all South Wales, and Mr. Williams I am sure will have pleasure in showing you the whole of the machinery. Amongst other interesting objects for your attention, you may here see the largest pump I ever heard of. The diameter of the working barrel is six feet, and the length of the lift in the barrel is four feet. It pumps up the whole of the river Taff, and the water, after turning all the wheels about the works, is discharged into the bed of the river. This may appear at first view, an expensive way of obtaining power, but experience shows that it is cheaper than erecting a number of small engines, or transmitting power through complicated machinery. Besides the Cyfarthfa, Messrs. Crawshay have the Hirwain works, which are situated about some six miles from Merthyr. At the two establishments there are in the whole fourteen blast furnaces, twelve at work, all blown with cold air, and two inoperative. They make about 900 tons of cast iron per week, and the greatest part of it is made into malleable iron, of which they produce 600 to 650 tons per week.

We next visit the Plymouth Iron Works, belonging to Messrs. Richard and Anthony Hill. Here are seven furnaces, all in blast, and all blown with cold air, making 700 tons of cast iron per week on an average, and from which they make about 600 tons into bars, &c., weekly.

About six miles from Merthyr, over a mountain, are situated the works of the Aberdare Iron Company. They have six furnaces in blast, two blown with hot, and four with cold air, prducing 350 to 400 tons cast iron per week. They make about 220 tons bar iron per week, and the remainder of their produce is disposed of for foundry purposes.

At the Pentyrch Iron Works, near Cardiff, there are two furnaces in blast, blown with cold air, and making about 150 tons cast iron weekly.

The whole of the iron made at the seven last named works is shipped at Cardiff, where a very commodious dock has recently been constructed by the Marquis of Bute, under the superintendence of William Cubitt, Esq., F. R. S., C. E., for the better accommodation of vessels entering that port.

The statistical information I promised to obtain, I found I should have great difficulty in procuring * * * I am compelled to offer you on these subjects the opinion of an excellent friend of mine, who has ample means of forming a tolerably correct estimate. His remarks are very general, and as such I offer them. He says, "To make 1000 tons of bar iron weekly, requires about 4000 persons of every description, but I cannot give you the proportionate numbers to each process. The rates of wages for men range from 12*s.* to 60*s.*, for women 6*s.* to 10*s.*, and for boys 7*s.* to 11*s.* per week."

There is another branch of statistics of the iron trade on which I felt desirous of affording you some information, and in obtaining this I have been somewhat more successful, though it was not procured without very great difficulty—I mean the proportions of the materials used in each process, and the waste of the iron. I am glad to say that I can inform you on these most important points with the utmost exactness. Fifteen furnaces, averaging ninety tons each per week, will produce 1350 tons of cast iron with a consumption of 50 cwt. of coal per ton of iron, inclusive of calcining—say 3375 tons of coal to furnaces and calcining, and to the blowing engines 10 cwt. of coal per ton of iron, or 675 tons. If the furnaces make 1350 tons of cast iron, 100 tons may be deducted for ballast iron. Then refining 1250 tons, at 22 cwt. 1 qr. of pig iron to the ton of refined iron, will produce 1110 tons refined metal with a consumption of 9 cwt. per ton, or about 500 tons of coal weekly for the refineries. 1110 tons of refined metal will yield of puddled iron at 21 cwt. per ton of the metal, and 18 cwt. of coal per ton of iron, 1045 tons with 940 tons of coal; and then the rolling mills at 22½ cwt. of puddled iron and 20 cwt. of coal per ton, will produce 915 tons of merchant bars, or what is called No. 2 iron, with a consumption of 915 tons of coal. * * * * *

Within the last three years, Mr. George Crane, of the Yniscedwyn iron works, has discovered, that by using heated air, he can melt iron ores with the anthracite coal. When I was last in South Wales, I visited Mr. Crane at his works, near Swonsea, in order that I might see and judge for myself of the merits of this discovery. To enable you to form some idea of its value and national importance, I need only inform you that it has added to the available resources of this kingdom, for the purposes of its iron trade, a district sixty to seventy miles long, by six to eight miles broad, abounding with the anthracite or carbon coal, lime, and iron stone; and further, that it has already trebled the value of this extensive mineral property. *

Mr. Crane has yet only one small cupola furnace, in which he uses anthracite exclusively; for firing the other two, he uses as I have before remarked, three-fourths bituminous, and one-fourth anthracite coal; and by using anthracite in this comparatively small proportion, he effects a saving of 12*s.* to 13*s.* per ton in the cost of making iron, and very materially improves its quality. His furnaces also yield a better produce, in proportions of 35 to 50 per cent. His small cupola furnace No. 2, from which, when using cold air and coke, he could obtain only twenty to twenty-two tons of cast iron per week, by being fired with anthracite coal alone, and blown with hot air has produced, on an average of many months, thirty-five tons per week, and the larger furnaces, in which he uses the proportions I have before stated, have increased, the No. 1, from thirty-four to thirty-five tons up to forty-five to forty-nine tons; and the No. 3, from fifty to fifty-five up to sixty-five to eighty tons per week. All his furnaces are very small, and his blowing machinery not so good as it ought to be, hence his very limited produce.

The quality of this iron is very highly spoken—Mr. Crane has received assurances from several parties who had used it for various purposes, that, "for bars it had given great satisfaction:" "for foundry work it was admirable;" that, "in re-melting, it was found very fluid, and at the same time very strong"—a union of qualities most desirable, but rarely to be met with.

With respect to the economy of this new process, Mr. Crane has, on the average of several months, produced the ton of cast iron with the before unheard of small quantity of 27 cwt. of coal, and he entertains the greatest confidence that he will be able to reduce the quantity still further, say

to 22 cwt. His main bed of anthracite coal is eighteen feet thick. I produce a sample of it as obtained from the mine.

The maturing of this most important plan has cost Mr. Crane much time and money and anxiety, and it is to be hoped that he will be most amply repaid for his valuable services.

This new feature in the iron trade soon attracted the attention of capitalists. both here and in London; and the counties of Pembroke, Carmarthen and the western part of Glamorgan, give fair promise soon, at least to rival Monmouthshire and the eastern part of Glamorgan, in the manufacture of iron. I will first enumerate the works already in operation in the Swansea and Neath districts, and then inform you of the extent to which new establishments are being erected and others contemplated.

The Maesteg iron works are worked by Messrs. Robert Smith and Co., with bituminous coal and hot air; they have two furnaces at work, producing from 180 to 200 tons per week of cast iron. A part of this they make into malleable iron, but I an not aware of the exact quantity—perhaps about sixty to seventy tons per week.

The make of Mr. Crane, at the Yniscedwyn iron works, I have already acquainted you with.

The Neath Abbey Iron Company have two furnaces in blast, blown with heated air, and fired with three-fourths bituminous and one-fourth anthracite coal. They make about 160 tons of cast iron per week, the chief part of which is made into castings on the spot, for their very extensive engineering establishment.

The Millbrook Iron Company have two furnaces in blast, producing about forty tons per week, blown with cold air.

The works erecting in the anthracite district are the Venallt, in the vale of Neath, and belonging to our enterprising townsmen, Messrs. Jevons and the Messrs Arthur of Neath. They are carried on under the firm of Jevons, Arthur, Wood and Co. They are building two furnaces, and hope to be in blast by the end of the year. They have a very abundant supply of both kinds of coal and ironstone.

Ystal-y-fera works near Swansea, are also being erected by a Liverpool company, at the head of which stands our spirited and excellent fellow-townsman, Sir Thomas Brancker. This company is building four furnaces and I am told that they intend building four more. Their fuel is all of the anthracite kind.

The Cambrian Iron Company are erecting four furnaces near Pile, on bituminous coal, and I have been informed, intend building four furnaces in the anthracite district. Messrs Mellins & Co. have one furnace near Pile.

The Gwendrath is a new work about to be established by a London company near Swansea, but I could not ascertain the extent to which they intend going. Mr. Crane informed me that he knew of twelve to fourteen new iron works, of from two to eight furnaces each, erecting, and about to be erected, in the anthracite district, the existence of which will be solely attributable to his invaluable discovery.

The aggregate number of furnaces in blast in South Wales, we have found to be 122; out of blast, 7; building, 31; and contemplated, 91; and allowing for the twelve works that Mr. Crane alludes to, as being likely to be erected soon, only five furnaces each, or sixty in all, we thus find that probably within the next five years the number of furnaces in South Wales will be doubled, and number 244. Allowing an average produce of eighty tons per week for each furnace, we have the astounding quantity of 1,015,040, or in round numbers, 1,000,000 tons of cast iron produced in this district alone—a quantity equal to that produced last year in the whole of Great Britain.—*C. E. & A. Journal.*

## ON CERTAIN FORMS OF LOCOMOTIVE ENGINES.—BY EDWARD WOOD.

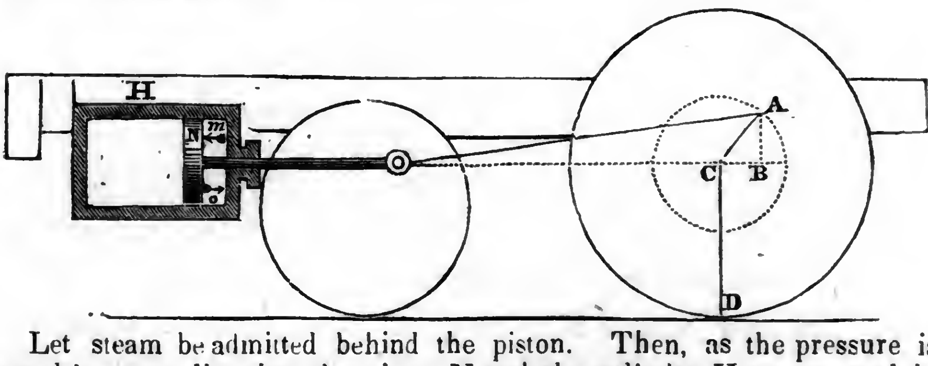
(Continued from page 332.)

### ENGINES WITH CRANK AXLES AND WITH OUTSIDE CRANK PINS.

The expense attending the construction of a crank axle, and its liability to fracture unless made with great care and of the best materials, have induced some builders to prefer a form of engine in which the large wheels are propelled by means of crank pins outside the wheels, and admit of being fastened on to a straight axle. The crank axle is thus dispensed with; the machinery is removed from under the boiler, and is consequently more accessible for examination and repairs; the boiler can be placed lower, rendering thereby the centre of gravity lower; and the large axle can be brought several inches nearer the fire-box. These advantages are of importance when they can be obtained without prejudice to the combined actions of the machine. In the present instance such is unfortunately not the case.

When the same shaft is impelled by two separate pistons, it is usual, and indeed it is most conducive to uniform motion, to place the crank pins at right angles to each other; that while one crank is "passing the centres," the other may be in full action. Hence, in engines worked by outside crank pins on the driving wheels, it occurs that at certain periods of the stroke, one *side* of the engine is impelled with the full force of one cylinder, while the opposite has ceased to be impelled by the other; that in fact the line of pull does not coincide with the line of direction in which the centre of gravity of the engine is moving, but alternately passes from one side of it to the other during every revolution of the working wheels. This variation induces an eel-like side motion and causes the flanges of the wheels to strike against the rails, and of course increases the friction. Such action has been always observed in engines of this construction, and is most injurious at high speeds. Being dependent on well known mechanical principles, the amount of the forces producing it may be ascertained.

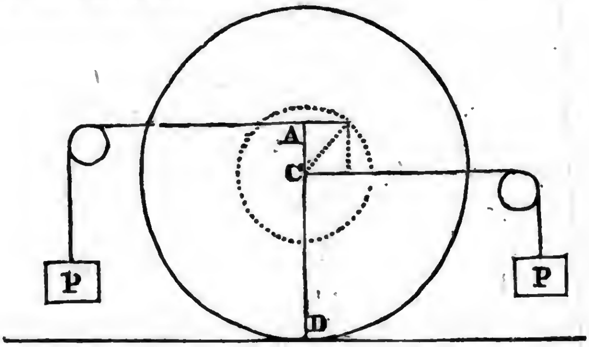
In the following figure, H represents the cylinder attached to the boiler or framing; N the piston; CD the radius of the working wheels; AC the crank arm; AB the sine of the angle made by the crank in moving from the *horizontal* position.




Let steam be admitted behind the piston. Then, as the pressure is equal in every direction, the piston N and the cylinder H are pressed in *contrary* directions with exactly equal forces. Now if the piston be pressed in the direction of the arrow *m*, with a force P, the pin A of the crank must be pressed in the *same* direction with the *same* force;* and again, if the cylinder be pressed in the direction of the arrow *o*, with a force P, the framing of the engine, the pedestals of the axle, and, in fine, the *centre* of

* The consideration of the inclination of the connecting rod, arising from its limited length, as effecting the force transmitted to the crank, is not here entered into, as it would introduce complexity without sensibly influencing the result.

the axle, must be pressed in the *same* direction and with the *same* force. Consequently, it is only by a difference of effect in these two opposite forces, in virtue of a difference of leverage, that any load can be drawn or any motion ensue. Whatever the forces may be, weights may be taken to represent them, and equivalent to them. Therefore to the point A of the lever AD (of which D is the fulcrum) apply the weight P, and to the point C of the same lever apply the weight P.




This arrangement will represent the relation of the two forces. If AC (the sine of the angle) have any value, motion must result *towards* the weight acting upon the longer arm of the lever, and the force producing motion must be equal to the extra weight required to be attached to C to restore the equilibrium.

Let this weight . . . . . . . . . . . $= x$
the semidiameter (CD) of the working wheel . . $= d$
And the angle through which the crank has moved from the horizontal line . . . . . . . . . $= \theta$

Then in the case of an equilibrium, the radius of the crank being unity, we have

$$P. \{d + \sin\theta\} = d. \{P + x\}$$

$$\text{and therefore } x = P. \frac{\sin\theta}{d}.$$

In like manner it may be shown, that this is also the expression for the impelling force when steam is admitted into the opposite end of the cylinder; for then

$$P. \{d - \sin\theta\} = d. \{P - x\}$$

$$\text{and therefore } x = P. \frac{\sin\theta}{d}, \text{ as before,}$$

the force acting upon the *cylinder* having in this case the ascendency.

Hence it follows, that the part of the engine to which the cylinder is attached, is urged forwards by a force (always represented by the expression $P. \frac{\sin\theta}{d}$) acting in a line which passes through the centre of the piston-rod, and affecting that part in a way precisely similar to what would have resulted, had an equal but *independent* force been applied from *without*. For it is clear that the extra weight or force $x$ acts in the vertical plane in which the centre lines of the piston rod, connecting rod, and crank pin are situate. If this plane coincide with that which passes through the line of direction of the centre of gravity, a direct impulse will be given to the engine, and no tendency will exist to disturb the equilibra of the parts adjacent to either side of that plane. But should the two planes *not* coincide, a disturbance will take place, greater or less, according to the magnitude of the interval which separates them. This disturbance would, however, be

counteracted, and the equilibrium restored, by applying on the *opposite* side of the central plane, at an equal distance, an equal force. A locomotive engine provided with cranks at right angles, is impelled by two separate forces, acting at *equal distances* from the central plane. But these two forces, although equal to each other in the aggregate effect produced during one revolution of the crank, are by no means equal during every instant of the time in which the revolution is performed. They are, in fact, very dissimilar; and it is, therefore, by their difference at any given moment that the engine is urged to move out of the right line. The force impelling one side of the engine has been shown to be

$$P.\frac{\sin\theta}{d}, \text{ or } \frac{P}{d}.\sin\theta.$$

in which expression it will be observed that P and $d$ are constant, $\sin\theta$ being alone variable; and that consequently the forces acting upon the sides, are respectively as the sines of the angles, and their *difference* equal to the difference of the sines multiplied by $\frac{P}{d}$.

For instance, put $P = 5000$ lbs.

$d = 3$ (the radius of crank being equal to unity.)

Then $\frac{P}{d} = 1666$ lbs., which, multiplied by the difference of the sines, gives the *excess* of force by which one side is impelled above the other.—Assuming the crank arm on the right side of the engine to be 90° in advance of that on the left, we perceive that, during one revolution of the axle, the force upon the *right* side has been twice equal to zero, while that upon the left has been at a maximum, or 1666 lbs. and that the force upon the *left* side has been twice equal to zero, while that upon the right side has been at a maximum.

It remains to explain what amount of side pressure is conveyed to the wheels under these circumstances. For this purpose it may be first assumed that the engine is placed upon a perfectly level plane, and is free to move sidewise without friction.

Let $W$ = the tractive power exerted.

$a$ = the force given out by one cylinder at some assigned moment.

$a + b$ = the force given out by the other cylinder at the same moment.

$r$ = the distance between the central plane and the plane which passes through the axis of the cylinder, piston rod, &c., (both planes being vertical and parallel to each other.)

$s$ = distance from the centre of gravity to the hind axle.

$s'$ = ditto from ditto to the fore axle.

Then, in the case of an equilibrium, we have $W = a + a + b$.

$a$ and $a$ being equal, and acting at equal distances from the central plane, will not tend to produce side motion; the unbalanced force $b$ will alone have that effect, and will cause the engine to turn about its centre of gravity. Let this tendency to turn be resisted by a force $w$, applied at right angles to the engine at a point opposite the centre of the hind axle; and by a force $w'$, applied in a similar manner, but on the other side, at a point opposite the centre of the fore axle. Then when there is an equilibrium,

$$b.r = w.s + w'.s';$$

also, $w's' = ws$;

therefore, $br = 2ws$,

whence, $w = \frac{1}{2}.\frac{br}{s}$

$$w' = \frac{1}{2}.\frac{br}{s'}.$$

Suppose $b=1666$ lbs.; $r=3$ feet; $s=1$ feet; $s'=5$ feet; then $w$, or the side pressure upon the hind wheel, is 2499 lbs.; and $w'$, or the side pressure upon the fore wheel, is 499 lbs.

The side pressure is resisted by the adhesion existing between the surfaces of the rail and wheel by the conical shape usually given to the tire, but especially by the flanges of the wheels. As in practice it is necessary to allow of some play between the flange and the side of the rail, a prejudicial swinging motion must arise. The nearer the cranks are brought to the centre of the engine, the more steady will its motion become; and when the line of application of the power coincides with the vertical plane of the centre of gravity, (as would be the case were the crank in the middle of the axle,) the force producing side motion altogether disappears.

On these grounds, outside cranks are undesirable, not only as tending, by the irregular motion they produce, to injure the wheels and axles, and to oppose considerable resistance to forward motion, but also as likely to prove injurious to the road. But outside cranks, in themselves objectionable, involve outside cylinders, and thence arises another reason for their rejection. Serious inconvenience must frequently arise from having the cylinders so directly exposed to the shocks and blows which their external position in the framing renders them liable to receive. In cases of serious collision, the front part of the framing is often broken. When the cylinders are inside, they are protected and sustain little or no damage. With outside cylinders the consequences have been more disastrous. The cylinders have been broken, and the adjustments of the machinery disturbed, to a degree which has required much time and labor to repair. To withstand the strains produced by the reciprocating action of the pistons, and the minor blows of daily occurrence, a strength of framing much greater than that of any inside cylinder engine is found necessary.

### COUPLED AND UNCOUPLED ENGINES.

The unfounded apprehension entertained at an earlier, though comparatively recent, period in the history of locomotion, that engines would be unable to advance with any considerable load, without some mechanical contrivance for promoting adhesion or resistance between the wheel and the rail, has now been removed; the simple force of adhesion between the clean surfaces of iron having been found sufficient to resists the power applied to the driving wheels for effecting forward motion.

The force of adhesion, when the surfaces are in a clean state, (either thoroughly wet or thoroughly dry,) equals at least one-fifth of the insistant pressure. Under such circumstances, an engine, the weight upon whose driving wheels is *five tons*, would exert a tractive power of *one ton*, or 2240 lbs. without slipping; in other words, would draw a load of 250 tons upon a level railway. A favorable state of the road is, however, far from being constantly obtainable. In a damp atmosphere the rails are often partially wet without sufficient moisture to wash them clean, and the adhesion may be reduced from one-fifth to one twenty-fifth of the insistant weight, and the engine may become unable to advance without slipping, with a load equal to more than one-fifth of what may be considered its maximum.—The usual load of a passenger train on the Liverpool and Manchester line seldom amounts to more than one-third or one-fourth of what the engine is able to draw at a slow speed upon any portion of the road; (with the exception of the incline of 1 in 96;) the power, as estimated *merely* by the dimensions of the cylinder, crank and wheels, and by the full pressure of steam being three or four times greater than the resistance to be overcome. The question of *speed* bears no reference to the power thus considered, being solely dependent upon the *rate* at which steam of the required

elasticity is generated. The adhesion, therefore, does not often prove less than sufficient for such trains, and it is on this account that the delays of passenger trains by the slipping of the engine wheels are comparatively trifling. Upon railways whose gradients are less favorable, or the loads heavier, the inconvenience from slipping may be expected to be increased. The application of a convenient and safe method of coupling would in these cases be very desirable.

In the transport of merchandize, the difference between a speed of 16 and 25 miles per hour is not of much object, and the slower rate is adopted as being on every account more economical. The engine being now able to take a heavier load, obviously and indispensably requires more adhesion. Luggage engines, and those that assist at the inclined planes, have therefore been provided with the means of coupling the wheels, or of rendering the whole (or nearly the whole) weight of the engine available in producing adhesion. For this purpose, the fore wheels and the driving wheels are made of equal diameter, and both pairs are so united by outside connecting rods that the one cannot turn independently of the other. This arrangement is simple, and on the whole very effective, but is nevertheless open to objections, which especially render its application to passenger engines unsafe.

1. There arises frequently great extra friction from strains, occasioned by unequal wearing of the wheel tires, and from want of proper adjustments in the connecting rods.

2. There is considerable difficulty in passing round sharp curves.

3. There is risk of the connecting rods *breaking.* Such accidents are not of uncommon occurrence. Engines have been occasionally thrown off the rails by the end of the connecting rod striking the ground.

4. High speeds are very liable to derange the connecting rods, and are therefore unsafe.

5. A coupled engine *when it slips* is subject to a very violent side motion, and a great strain is thrown upon the wheels, the outside cranks and the rods.

6. In a clean state of the road the connecting rods are not wanted, and only act as an incumbrance.

7. The fore wheels being of equal diameter with the driving wheels, the piston rod must work under the fore axle; the cylinders are then placed lower and in an inclined position. The *weight* of the fore wheels is likewise increased.

A mode of coupling, the invention of Mr. Melling, of this railway, has been applied successfully during the last year and a half upon the "Firefly" engine, which promises to remove the preceeding objections, and is therefore peculiarly adapted to passenger engines. Whether this plan may as effectually prevent slipping as that now in common use, is a point which perhaps still remains to be decided: but that it is effective in a great degree cannot be denied. Having had occasion to make several experiments bearing upon the subject, I shall give a brief outline of the results.

The apparatus consists of a small independent wheel, which can be pressed downwards, with considerable force, between the outer rims or tires of the driving and the fore wheels and consequently can be made to transmit to the rim of the fore wheel the power given out at the rim of the driving wheel. The requisite force is obtained by opening a communication between the boiler and a small cylinder, the piston of which with the assistance of suitable levers, is made to press the coupling wheels downwards.

Adhesion between the wheel and the rail is obviously proportional to the weight which exerts its pressure upon the two surfaces. When the rails

are in a dry state, the weight upon the driving wheels produces adhesion sufficient to enable an engine to advance with a maximum load without slipping; but a slight greasy moisture diminishes the adhesion, and the wheels slip without advancing.

Under the last mentioned circumstances, the driving wheels alone of an uncoupled engine can slip, and no benefit would accrue from the weight sustained by the fore wheels. On the other hand, the driving wheels of an engine coupled with connecting rods cannot slip without at the same time causing the fore wheels to revolve. In this case the full benefit of the weight upon the fore wheels is obtained. It will, then, be evident that the method of coupling by a "contact" wheel, can only produce the extra adhesion in virtue of a transmission of the power from the driving wheel to the fore wheel, through the medium of the resistance opposed to the friction of iron *sliding* upon iron at the surface of the small coupling wheel. Such resistance, when the surfaces in contact are clean, is known to be very great and would be sufficient to turn the fore wheels were they resting upon a slippery rail. But the greasiness of the rail is in some measure transferred to the wheel itself, and necessarily diminishes the adhesion of the coupling wheel. It might then be expected, that, while this wheel would in every case increase the total adhesion, it still would not exert a degree of power capable of overcoming the adhesion between the fore wheels and the rails. However, on reversing the engine suddenly, and applying the coupling wheel, I have frequently observed the fore wheels completely locked and sliding upon the rails. The following experiments were made with the view of ascertaining roughly, what difference in the amount of slipping the removal of the coupling wheel would produce, under equal conditions of load. The load assigned to the engine was that of pulling its tender with all the wheels locked. A slippery part of the road was chosen and two stakes were there driven into the ground, 320 yards assunder. Proper counters were also attached to the wheels for registering the number of revolutions. The engine being brought opposite to one of the stakes, the regulator was opened to its full extent.

EXPER. 1. Coupling wheel *in action.*
Large wheels made 92 revolutions.
Small ditto 87 ditto.

EXPER. 2. Coupling wheel *not in action.*
Large wheels made 136 revolutions.
Small ditto 87 ditto.

EXPER. 3. Coupling wheel *in action.*
Large wheels made 65 revolutions.
Small ditto 85 ditto.

EXPER. 4. Coupling wheel *not in action.*
Large wheels made 337 revolutions.
Small ditto 85 ditto.

Had the driving wheels not slipped, they would have made only 59 revolutions in the 329 yards; so that in the

| | | | | |
|---|---|---|---|---|
| 1st | experiment | 33 | revolutions | were slipped. |
| 2nd | ditto | 77 | ditto | ditto. |
| 3d | ditto | 6 | ditto | ditto. |
| 4th | ditto | 278 | ditto | ditto. |

The first and third experiments, being those in which the wheel was applied, are evidently the most favorable.

By this method wheels can be coupled whatever be their respective diameters, under the condition, which must obtain in every locomotive, of an equality of velocity in the revolving surfaces. The coupling wheel is

under the entire control of the engine man, and can be applied or removed at pleasure, without the necessity of stopping or even checking the motion of the engine. It is, however, subject to one mechanical imperfection. The tires of the engine wheels are conical, and therefore admit of connection only by the frustrum of a cone whose apex points in an opposite direction. Hence the outer edge of the tire iron revolves with a less velocity than the inner edge, while the relative velocties of the outer and inner edges of the coupling wheel are precisely reversed. A perfect contact between the two surfaces throughout their entire width would occasion much friction by the sliding of the parts upon each other, and indeed would be otherwise objectionable on the ground of lessening adhesion, experience having well established the doctrine, that the narrower the bearing surface, the greater is the adhesion under equal pressures.

It became an interesting matter of inquiry to ascertain the amount of impeding friction produced by the full application of the coupling wheel, to determine what proportion of the useful effect of the engine would be absorbed. A set of experiments, conducted in different ways, viz: by the angle of friction, by the dynamometer, and by a maximum load, were carefully made. The results agreed very closely, and the mean obtained gave

120 lbs. as the absolute friction of the engine when *uncoupled ;* and

200 lbs. as the absolute friction with the coupling wheel in full action. The difference, 80 lbs., being due to the method of coupling. It may be observed, that 200 lbs. is scarcely less than the absolute friction of an engine coupled in the ordinary manner. When, however, we take into account the difficulties attending the adjustment of the connecting rods, whether in keying the brasses so accurately as to enable the cranks to pass the centres without strain; or in turning, and after they have been turned, preserving a precise equality in the diameters of the wheels, the conclusion at which we arrive does not seem premature, that on an average of circumstances the diminution of useful effect is less upon the system of coupling by contact, than upon that of coupling by connecting rods. If the rails be dry, the coupling wheel is lifted off and remains idle; but connecting rods *must* continue working, and then act only as an incumbrance. In damp weather only can the two modes come into competition. Whatever tendency to slip exists in the driving wheels must be transferred to the fore wheels. In the one case a constant pressure produces a constant resistance; in the other a variable resistance is occasioned by a friction of the joints of the connecting rods, increasing with every addition to the weight of the load.

EDWARD WOODS.

*Manchester, Jan.* 8, 1838.

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## THEORY OF THE STEAM-ENGINE.

(Continued from page 348.)

### *Section VI.—Of the conservation of the maximum density of the steam for its temperature, during its action in the engine.*

When an engine is at work, the steam is generated in the boiler at a certain pressure; from thence it passes into the cylinder, assuming a different pressure, and then, if it be an expansive engine, the steam after its separation from that of the boiler, continues to dilate itself more and more in the cylinder, till the end of the stroke of the piston. It is commonly supposed that, during all the changes of pressure which the steam may undergo, its temperature remains the same, and the consequent conclusion is that, during the action of the steam in the engine, its density or relative volume follows

the law of Boyle or Mariotte; that is to say, the relative volume varies in the inverse ratio of the pressure. This supposition simplifies indeed the formulæ considerably, but we shall presently see that it is contrary to experience; and therefore it becomes necessary to seek what is the true law, according to which the steam changes temperature in the engine, at the same time that its pressure changes. And as calculations relative to the effects of steam, depend essentially on the volume it occupies, we must seek also what changes that volume undergoes, by reason of the variations of temperature and pressure, which take place in the steam during its action.

We shall then substitute for the relation precedently indicated, another more real, and, what is essentially necesary to calculate the effects of steam with accuracy, deduced from the facts themselves.

We have just said that the calculations relative to steam-engines suppose the steam to preserve invariably its original temperature, which allows the application of Boyle's or Mariotte's law to all the changes of density or of pressure it may undergo. However, as it is known that elastic fluids never dilate without cooling in some degree, this supposition obviously could not be realized, but on condition that the steam have time to recover from the bodies with which it is in contact, supposed to be sufficiently heated, the quantity of caloric necessary to restore its temperature, after expansion, to the same degree at which it was before. Now, the rapidity of the motion of the steam in the cylinders and the pipes will not suffer the admission of such an hypothesis.

To obtain satisfaction on this head, in a numerous series of experiments which will be found related in the second edition of our Treatise on Locomotives, we adapted to the boiler of a locomotive engine, a thermometer and an air-gauge or manometer; we applied also two similar instruments to the pipe through which the steam, after having terminated its action in the engine, escaped into the atmosphere; and observed their simultaneous indications. The steam was generated in the boiler at a total pressure varying from 40 lbs. to 65 lbs. per square inch, and escaped into the atmosphere at a pressure varying, according to different circumstances, from 20 lbs. to 15 lbs. per square inch. Had the steam preserved its temperature during its action in the engine, it would have issued forth with the pressure, for instance, of 15 lbs. per square inch, but with the temperature proper to the pressure at which it had been formed, that is, 65 lbs. per square inch. Now, nothing like this took place; during some hundreds of experiments wherein we observered and registered these effects, we found invariably that the steam escaped precisely with the temperature suitable to its actual pressure; so that the thermometer, graduated to indicate the pressure in the steam of maximum density, gave identically the same degree of pressure as the air-manometer, and accorded equally with a siphon-manometer, which we had superadded to the apparatus at the point of the outlet of the steam. The steam then was generated in the boiler at a very high pressure and quitted the engine at a very low one; but, on its leaving the engine, as well as at the moment of its production, the steam was at the same temperature that it would have had, if immediately formed at the pressure which it had at the moment of the observation.

Consequently, we are to conclude from these experiments, that during its whole action in the engine, the steam remains in the state of steam at the maximum pressure or density for its temperature. Hence it results that, when the pressure of the steam changes in the engine, its temperature changes spontaneously at the same time, and *vice versa;* so that they always preserve the mutual relation which connects the pressures and temperatures in the steam in contact with the generating liquid.

Now, we have shown in the fourth section of this chapter, that, with regard to steam in contact with the liquid, the *relative* volume, that is the ratio between the volume of the steam and the volume of an equal weight of water, may be expressed in terms of the pressure by the following very simple formula,

$$\mu=\frac{1}{n+qp}, \quad . \ . \ . \ . \quad (a)$$

in which $\mu$ is the relative volume of the steam, $p$ the pressure expressed in pounds per square foot, and the constant quantities $n$ and $q$, have, according to the engines considered, the numerical values already indicated, viz.:

*Condensing engines:*

$$n=\cdot00004227 \quad . \ . \ . \ . \quad q=\cdot000000258;$$

*Non-condensing engines:*

$$n=\cdot0001421 \quad . \ . \ . \ . \quad q=\cdot00000023.$$

This relation, then, will be applicable to all the states of the steam during its action in the engine.

Now, according to equation ($a$), if we suppose that a certain volume of water represented by S, be transformed into steam at the pressure $p$, and that we call M the *absolute* volume of steam which will be produced by it, we shall have,

$$\mu=\frac{\mathrm{M}}{\mathrm{S}}=\frac{1}{n+qp}.$$

If afterwards the same volume of water be transformed into steam at the pressure $p$, and that we call M′ the *absolute* volume of the resulting steam, we shall have also,

$$\frac{\mathrm{M}'}{\mathrm{S}}=\frac{1}{n+qp'}.$$

Consequently, between the *absolute* volumes of steam which correspond to to the same weight of water, we shall have the definitive relation,

$$\frac{\mathrm{M}}{\mathrm{M}'}=\frac{\frac{n}{q}+p'}{\frac{n}{q}+p}; \quad . \ . \ . \ . \quad (b)$$

that is to say: the volumes of the steam will be, not in the inverse ratio of the pressures, as was supposed in admitting Boyle's or Mariotte's law, but in the inverse ratio of the pressures augmented by a constant quantity.

The last equation gives also

$$p=\frac{\mathrm{M}'}{\mathrm{M}}\left(\frac{n}{q}+p'\right)-\frac{n}{q}. \quad . \ . \ . \quad (c)$$

And the two equations ($b$) and ($c$) will serve to determine either M, or $p$, according to the one of these two quantities, which will be unknown.

These relations then must be substituted for that of Boyle or Mariotte, which is not applicable to the operation of steam in the steam engine.

As, in all calculations relative to the effects of steam engines, the volume occupied by a given weight of steam forms the important element of calculation, it is very obvious that the use of the above principle; that is, of the *conservation of the maximum density of the steam for its temperature*, during its action in the engine, and the formula by which we have represented it, will tend to the avoiding of many considerable errors in the results.

If we consider, for instance, an engine in which the steam generated at the pressure of 8 atmospheres, or 120 lbs. per square inch, shall expand to 10 lbs. per square inch; then in the usual mode of calculation, it will be supposed that the steam during its expansion, will preserve its temperature

and that its volume will vary in the inverse ratio of the pressures. The volume of the steam at the pressure of 120 lbs. per square inch is 249 times that of the water which produced it. If its temperature remained unchanged during its action in the engine, its volume after the expansion would become

$$249 \times \frac{120}{10} = 2988.$$

The supposition, then, amounts to admitting that under the pressure of 10 lbs. per square inch, the volume of the steam would be 2988 times that of the water. Now, from accurate tables, this volume is 2427. An error, then, is induced of $\frac{1}{5}$ on the real volume of the steam, that is to say, on the effect of the engine; and this error will be almost entirely avoided by the use of our formula, since it gives in this case 2417, instead of 2427, that is to say, it differs inconsiderably from the true volume of the steam.

Let us, however, add, that in slight differences of pressure, such as take place in some engines, the error may become scarcely noticeable.

## CHAPTER III.—GENERAL THEORY OF THE STEAM-ENGINE.

### ARTICLE I.—OF THE EFFECT OF STEAM-ENGINES, IN THE CASE OF A GIVEN EXPANSION, WITH ANY VELOCITY OR LOAD WHATEVER.

*Section* I. *Of the different problems which present themselves in the calculation of steam-engines.*

After having exposed succinctly, in the first chapter of this work, the manner in which we conceive the mode of action of the steam in steam-engines, we now proceed to the full development of the theory of which, as yet, we have given but a very imperfect sketch, and to the solution of the different problems that may occur in the working or in the construction of steam-engines.

We distinguish three cases in the working of a steam-engine; that in which it works at a given expansion of the steam, and with any load or velocity *whatever;* that in which it works at a given expansion, and with the load or velocity proper to produce its *maximum useful effect with that expansion;* and lastly, that in which the expansion having been previously regulated for the most favorable working of the steam in that engine, it is loaded, moreover, with the most advantageous load for that expansion;—which consequently produces the *absolute maximum useful effect* for that engine.

We have already observed, that the three fundamental problems of the calculation of steam-engines consist in finding successively the velocity, the load, and the evaporation of the engine. After the solution of these three problems, that which first presents itself as a corollary to them, consists in determining the useful effect of the engine, which determination itself may be expressed under eight different forms, viz., by the number of pounds raised one foot by the engine in a minute; by the force of the engine in horse power; by the effect of 1lb. of coal; by the effect of one cubic foot of water evaporated; by the number of pounds of coal or of cubic feet of evaporated water, necessary to produce one horse power; and finally, by the number of horses represented by each pound of fuel consumed or by each cubic foot of water evaporated. We have, then, to give successively the means of solving these different questions.

For the sake, however, of greater precision, the following are the problems we purpose to solve in a general manner, for each of the three cases above noticed, and for the different kinds of engines.

1. Given the load of an engine, in other respects fully known, to determine what velocity the engine will assume with that load.

2. Knowing, on the contrary, the velocity at which it is intended to work the engine, to determine what load it can set in motion at that velocity.

3. Given the load to be moved by the engine and the velocity at which it is to move, to determine what evaporation the engine must be capable of, and consequently the dimensions requisite for the boiler, in order to produce the desired effects.

4. The evaporation, the pressure, and the dimensions of an engine being known, to calculate the useful effects it will produce in a given time, at a determined velocity or with a determined load.

To determine, from the same data, the horse power of the engine.

Having the same data, and moreover the consumption of fuel per hour to find successively :—

The useful effect the engine will produce per pound of fuel.

The useful effect the engine will produce per cubic foot of water evaporated.

The weight of fuel that will produce one horse power.

The volume of evaporated water that will produce one horse power.

The horse power which will be produced by the consumption of one pound of fuel.

The horse power which will be produced by one cubic foot of water evaporated.

These various problems will be solved in the three cases mentioned above. Consequently in the two latter, the question will be to calculate the velocity, the load, and the effects, corresponding to the *relative* or *absolute maximum useful effect of the engine.*

In the ordinary theory of steam-engines, the solution of three questions only had ever been attempted ; namely, to determine the load, the evaporation, and the useful effect (under different forms ;) and we have seen that their solution was defective. As for determining the velocity of the engine for a given load, no solution had ever been proposed ; and the very nature of the theory employed did not permit of distinguishing in the engine, the existence of the three cases which do in reality occur. It is possible, then, that the questions we have just presented may at first appear rather obscure, expressed as they are in general terms, and inferring relations under which it is not usual to consider steam-engines ; but they will be explained as we proceed, and their indispensable necessity will be felt, to calculate with accuracy either the proportions or the effects of steam engines of every kind.

(To be continued.)

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## SPEED ON RAILWAYS, A COMMUNICATION BY THE COMPT DE PAMBOUR TO M. ARAGO.

The resistance of the air to bodies which travel through the atmosphere with a rapid motion, having given room to some persons to imagine that locomotive engines could never attain a very great velocity on railways, I think it will be interesting to you to know, that in an experiment I have just made (on the 3rd August,) upon the Great Western railway between London and Maidenhead, we attained a speed of 55·4 English miles per hour. The experiment was performed by the "Evening Star" locomotive manufactured by Mr. Robert Stephenson, of New Castle ; it has wheels of 7 feet diameter, and drew only the tender loaded with 8 persons. It maintained easily, during 7 or 8 miles, a speed of 45 miles per hour, afterwards

for a distance of 3 or 4 miles, a speed equal to 48 miles per hour, and at last, two miles were travelled over, each in one minute and five seconds, which gives a velocity equal to 55·4 miles per hour. Although this very rapid motion gives one the idea that we are left to the mercy of chance, by the difficulty there would be to stop the engine in time, in consequence of the almost complete instantaneousness with which obstacles present themselves, to overcome this difficulty it would be necessary to increase the inspection of the state of the railway, and to employ rapid means of transmitting to a distance, by signals, the state of the road.

With the engine employed for the experiment we were not able to go beyond the speed stated above, because the pump was not sufficiently large to feed the boiler, consequently we were obliged to suspend the vaporisation, and to decrease the speed, until the boiler was again replenished with water; but there is no doubt that in only enlarging the diameter of the pump and feeding pipes, we might be able to maintain the greatest speed for a long distance—and even to go beyond it. Speed equal to what I have reported has already been mentioned in some journals, but as these statements are often made upon heresay evidence only, I have thought that it would be useful to you to be informed of it by the experimentalist himself. I have not given here the different dimensions of the engine, because my only object now is to make known the facility that there is in attaining considerable speed. I shall only add that the Great Western railway is sensibly a level.

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*Mechanical Brick Making.*—At the meeting of the British Association at Birmingham, Mr. Cottam exhibited a model of a brick and tile making machine invented by the Marquis of Tweeddale, by which it was stated 30 bricks a minute, or nearly 30,000 bricks a day, might be made, while a good moulder could only mould from 5000 to 8000 a day. The clay was put into the machine at one end, and passing between two rollers was rolled into a long bar, which was cut into the required length of the bricks by a cutter worked by the same wheel-work. The bricks, on coming out at the opposite side of the machine, were carried by it to a distance of 200 yards, thereby saving a great amount of time and money in carrying, an operation usually performed by boys and women. As a proof of the superiority of the machine-made brick, it weighed 8 1-4 lbs., while a common brick weighed only 5 3-4 lbs., and the machine-made brick carried eight times the weight which the common brick would sustain.

*A new method of preserving iron work from rust* has been communication by M. Paymen to the French Institute. It consists in plunging the pieces to be preserved in a mixture of one part concentrated solution of impure soda, (soda of commerce,) and three parts water. Pieces of iron left for three months in this liquid had lost neither weight nor polish; while similar pieces immersed for five days in simple water were covered with rust.

*Roman Pavement.*—Lately in excavating the ground for rebuilding the hall of the Worshipping Company of Dyers, in College street, Dowgate hill, at 13 ft. 8 in. below the level of the street, and just above the gravel, the workmen came to the remains of a Roman pavement, formed of small pieces of tiles about an inch square, bedded apparently on fine concrete.

*Suspension Bridge across the Danube.*—The patent for the construction of this bridge is granted to the Baron Signa, and will be proceeded with immediately. It will cross the Danube between Pesth and Ofen, and will connect Hungary with Austria. Mr. Tierny Clark, who built the Hammersmith Suspension bridge, is to be the engineer.—***Railway Mag.***